


ANALOG[®]



SCIENCE FICTION AND FACT

**SPECIAL
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ISSUE!**

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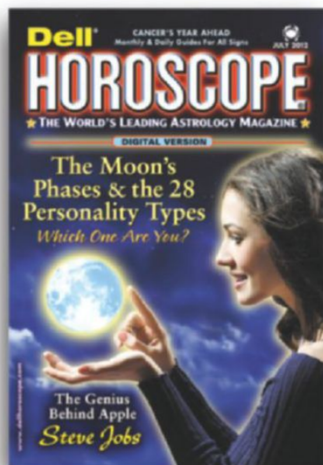
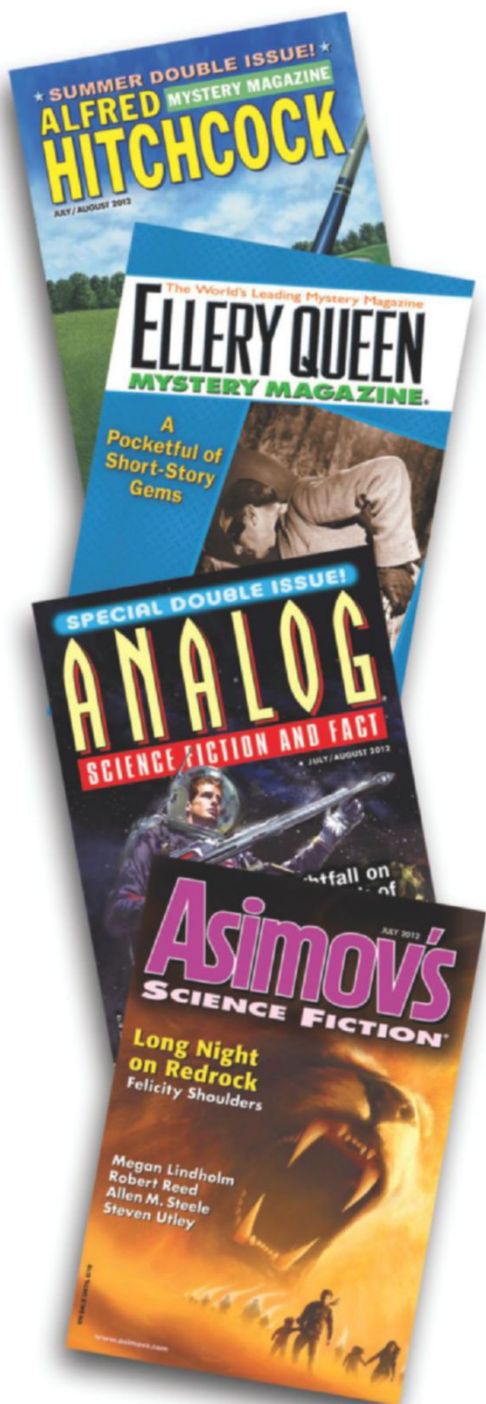
**Richard A. Lovett
Sean McMullen
Gwendolyn Clare
Michael Carroll
Stanley Schmidt
Ben Bova**

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ANALOG

SCIENCE FICTION AND FACT

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32

NOVELETTES

THE WORMHOLE WAR, Richard A. Lovett	8
THE AUDIENCE, Sean McMullen	89

SHORT STORIES

VERY LONG CONVERSATIONS Gwendolyn Clare	32
THE KROC WAR, Ted Reynolds & William F. Wu	40
STRATEGIES FOR OPTIMIZING YOUR MOBILE ADVERTISING, Brenta Blevins	53
THE ODDS, Ron Collins	55
THE EMPATHY VACCINE, C.C. Finlay	57
THREE BODIES AT MITANNI, Seth Dickinson	63
SHIPS IN THE NIGHT, Jay Werkheiser	84

SCIENCE FACT

REALLY BIG TOURISM, Michael Carroll	26
-------------------------------------	----

SPECIAL FEATURES

A FUTURE FOR ANALOG, Stanley Schmidt	5
JOHN W. CAMPBELL, JR., Ben Bova	48
THE ANALOG MILLENNIUM, Mike Ashley	73

POEM

FLIGHT, Mack Hassler	62
----------------------	----

READER'S DEPARTMENTS

THE EDITOR'S PAGE	2
THE ALTERNATE VIEW, Jeffrey D. Kooistra	45
IN TIMES TO COME	52
THE REFERENCE LIBRARY, Don Sakers	102
BRASS TACKS	106
UPCOMING EVENTS, Anthony Lewis	108

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Indicia on Page 3

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PULP FRICTION

In case you didn't catch the bold banner on the cover or read last month's *In Times to Come*, the magazine you're holding in your hand is kind of a big deal: it's *Astounding/Analog*'s 1,000th issue.

That's a momentous occasion, to be sure, but it gets put in its proper perspective much more thoroughly, by a much more knowledgeable source, later on in the magazine (see p. 76), so I won't dwell too much here.

The keen-eyed and historically minded may also have noticed that the cover is a bit . . . familiar. That's because, though it *is* commissioned (and lovingly executed by Vincent DiFate), it doesn't illustrate a story in this issue. It illustrates (more or less) a story from our very *first* issue: "The Beetle Horde," by Victor Rousseau, from the January 1930 issue of *Astounding Stories of Super-Science*¹ (and originally painted with watercolors for the cover of that issue, by H. W. Wessolowski).

Personally, I've always *loved* that cover. There's something about it that brings out my inner eleven-year-old. If you're not familiar with it, it depicts a man in a flight suit (*not* a bomber jacket, as Vinny DiFate politely pointed out about my less-than-accurate description when I was commissioning the piece) standing in front of a crashed biplane, protecting some kind of cave-woman by punching a six-foot, bipedal beetle square in the mandible.

The story itself hasn't aged especially well. The prose sounds dated to modern ears; the tone of the narrative is all over the place, ranging from deathly serious to more than a little goofy—the first installment ends with our intrepid heroes finding a giant beetle with a prayer book: an actual "Praying Mantis," they observe, straight-faced; and the villain of the piece, Bram (a mad scientist, of course—one of my least favorite archetypes ever, as one might guess of the editor of a pro-science publication), is motivated by an academic grudge over whether or not banded ant-eaters existed in the fossil record prior to the Pleistocene.²

And the science, even by the standards of the day, is not . . . (he said tactfully) a priority. (Did I mention the giant bipedal beetles? Square-cube law, anyone? Or that it's a Hollow Earth story, complete with uphill rivers?)

So, on one hand, it's understandable that John W. Campbell made an effort to move away from that kind of story once he took the reigns. John Clute, in the ever-indispensable *The Encyclopedia of Science Fiction* (St. Martin's Griffin, 1995, p. 63), says of that early period of *Astounding*: "*ASF* was unashamedly an action-adventure pulp magazine where 'science' was present only to add a veneer of plausibility to its outrageous melodramas." It's very much the antithesis

¹ "A Startling Story," as the cover deems it, "The Beetle Horde" is the first story in the issue, so it's technically the first *Astounding/Analog* story, period.

² Turns out, history would prove poor old "Mad" Bram correct—R. A. Stilton found the jaw of a fossil peramelemorphian species from the Pliocene in 1955.

of Campbell's vision for what would eventually become *Analog*,³ wherein fleshed-out characters and realistic science are integral to what we do (though of course I don't have to tell you that, Dear Reader).

And yet . . .

And yet.

Unlike Campbell, I like the name "Astounding." No doubt to him it conjured associations of, well, beetle-punching, and all the other things folks (sometimes rightfully) looked down at early SF for. But to me it only brings to mind derring-do and larger-than-life adventure. I like stories where heroes solve their problems with their brains . . . but that doesn't mean they don't *also* have fists.

So how do I square that early version of the magazine with the much matured title that I am steward of?

The essence, to me, of what's so appealing about that cover—like the story it illustrates, and the name of the magazine they appeared in, and the pulps in general—is its energy and complete lack of inhibition. The blurb on the table of contents reads: "Only Two Young Explorers Stand in the Way of the Mad Bram's Horrible Revenge—the Releasing of His Trillions of Man-sized Beetles upon an Utterly Defenseless

World," capitalization per the original. How do you read that and *not* want to pump your fist and growl, "Hell yeah," let alone flip to the story and start reading it immediately?

We were as pulpy as they came: Clayton Magazines, *Astounding's* original publisher, had such other periodicals as *Ace-High Magazine* (Westerns, not air combat, as one might assume), *Ranch Romances* (self-explanatory, I think), *All Star Detective Stories*, *Wide World Adventures*, and the rather bluntly titled *Five-Novels Monthly*, in their stable. None of them were the *New Yorker*, but they weren't trying to be, and they were refreshingly honest about it. No unlikely attempts at a spot on college reading lists here.

On a certain level, it doesn't matter if the science was bad and the characters were flat—we can fix that. But it would be both an error and a shame to assume that moving away from those pulpy origins meant we also had to lose that unpredictability and sense of fun.

So, that cover? Glorious. I love it, I love what it represents, and this month's cover is a love letter to it.⁴ If a person can be in touch with their inner child, then maybe so can an institution like a magazine. Just

³ I don't want to sound like I'm criticizing or even just appreciating any of it ironically—I *genuinely* love that cover, and the editors did a lot right; I can only hope that some editor eighty-five years from now looks back on anything I do so fondly.

⁴ You may notice that there's one big difference between this cover and the original—there's no cowering cave-woman being protected by a two-fisted adventurer; this time, she's more than capable of handling the bug on her own. Taking the things that work without being beholden to the things that don't is about as Futurist a concept as there is.

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because we've matured (mostly) and gotten a haircut doesn't mean we've forgotten the lyrics to the songs we liked back when we were young punks. It's still a part of who we are, even after a thousand issues; it's in our DNA.

If First Contact ever arises, I hope our first order of business is using all of our resources, both mental and technological, to

try to open a dialog with beings that evolved on a distant planet, overcoming all the hurdles an alien biology and culture present, understanding what is surely a vastly different way of seeing the Universe. But if push comes to shove, I also hope we're not above getting in our flight suits and smacking that alien in his smug, beetle mouth. ■

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A Future for *Analog*

Stanley Schmidt

When John W. Campbell started editing *Astounding*, astronauts existed only in the pages of science fiction. Shortly after I stopped editing *Analog*, an astronaut came to my Kaffeeklatsch at the World Science Fiction Convention.¹

I got a kick out of that, and I think John would have, too. What better vindication could he want for his oft-repeated claim that *Astounding/Analog* was an analog simulator for possible futures? Its stories had often explored futures in which astronauts played prominent roles, and the presence of a real one at a gathering of science fiction folk demonstrated dramatically that some of those simulations had a solid basis.

Some might even say it meant, “Mission accomplished: prediction realized!” I can agree with that only in a very limited way, since I know that science fiction has never been in the business of predicting the future. But I think it means something even more important.

I believe it was Harlan Ellison who told the story, many years ago, of being approached

by a woman who asked, “So what are you people going to write about now that we’ve been to the Moon?”

Harlan, as I remember the story, told her, “Lady, there hasn’t been a Moon landing story in twenty years.”

But there had been a whole lot of other kinds of stories—and there still are, and will be for a long time to come.

In a similar vein, Frederik Pohl once said, “The mistake you must never make about science fiction is in thinking that, because it is about the future, it is necessarily about *the* future.” Writers in this field are seldom trying to predict what the future *will* be, but rather to imagine a wide range of ways it *could* be—and how each of them, if it came to pass, would affect our lives.

And what we could do about it.

So when somebody asks, “Where is my flying car?” as an excuse for sneering at science fiction’s “failures,” he or she is missing the point. Since we’re trying to imagine a full range of possibilities, it’s inevitable that most

¹ In case you’ve never been to one, a Kaffeeklatsch at a science fiction convention is a program event at which a small number of attendees get together for an informal, uninterrupted conversation with somebody in the business.

of them won't happen. We expect that, and it doesn't mean that we've failed.

But when one of them *does* happen, and science fiction readers have a leg up on everybody else because they've already been thinking about it, that's a success worthy of pride—maybe even a bit of gloating. Like the time, somewhere around the middle of my stint of editing *Analog*, when much of the populace was aghast at the shocking (to them) announcement that somebody had cloned a sheep. A reporter at one of the major news magazines called me up and asked me, "What's your take on this?"

My answer was immediate: "Ha! We told you so!"

Whereas much of the general populace was caught off guard by the announcement, science fiction writers and readers—especially of this magazine—had known for many years that something like this was almost sure to happen. The only real unknowns were the details of when, where, and how. We were already way beyond being shocked at the possibility that somebody could do it awkwardly with a sheep, and well into consideration of such questions as when it might be done well with humans, and the ethical and legal dilemmas that would surely arise as a result.

And our answers to those questions were not knee-jerk shock or horror. We were *thinking* about them, because we knew that someday they were likely to matter—and when they did, simplistic, reflexive answers (like "Ban GMOs!") would not serve us well.

The same thing happened with many other concepts. Organ transplants, nuclear energy, communication satellites, global warming, genetic engineering, robots, surveillance drones, the danger of (and need for defense against) asteroid impacts, computers, artificial intelligence—even the internet, though in that case reality has already gone far beyond what most of us imagined. I (or you) could easily write a much longer list of things that are already parts of everyday life but just a few years ago were either undreamed of or dismissed as "just science fiction" by much of the populace. Those of us in "the biz" could

easily gloat that we imagined these things long before they happened, but the real value of that imagining lies in the fact that we had a head start on thinking about how we might deal with them.

We have also imagined a lot of things that *haven't* happened, like humanoid robots, time travel, interstellar travel, and face-to-face contact with extraterrestrial intelligences. Some of them will probably never happen, and our advance thinking about them may never be needed. Time travel, for example, at the moment looks like a long shot at best, and interstellar travel, while theoretically possible, currently looks extremely difficult and expensive. But fundamental breakthroughs can still happen, and we can't absolutely rule any of them out. So it's still worthwhile—and fun—to think about the possible consequences if any of them do happen.

Meanwhile, science fiction's successes have, perhaps ironically, created new obstacles to its own continued acceptance and future success. The world we live in is now so full of things that were recently "just science fiction" that the line between reality and science fiction has, for many people, blurred almost to invisibility. One of my novels² has a scene set a couple of decades hence in which a science fiction convention is attended almost exclusively by old people, because only they still see science fiction as a separate genre from fiction generally. We're not there yet, but it has become even easier for people who don't understand what we're doing to ask, "So what are you people going to write about now that we've done _____?"

Or, to put a more personal face on it, does a magazine like *Analog* still have an important role in the future?

My answer is: You bet it does, and maybe more than ever. I'm immeasurably delighted to see *Analog* reach the milestone of its thousandth issue and even more delighted to see it poised to continue the important work it's been famous for into the next thousand.

The first part of that work, of course, is to entertain: to tell stories that draw readers into imagined worlds and make them glad for

² *Argonaut*, Tor Books, 2002; available as print-on-demand and in various e-book formats from FoxAcres Press.

the time they've spent there. Other kinds of fiction do that too, but in most fiction the imagined worlds are essentially, except in detail, the one the reader lives in. They rely almost entirely on the same kinds of human interactions that have played out in stories for thousands of years: sex, violence, greed, love, hate, jealousy, deceit, political intrigue, etc. Literature teachers call that "universal and timeless"; I call it limited, limiting, and, by itself, ultimately boring.

All those things will continue to be important in our future, and in our fiction, but *Analog* readers know there's a lot more to the Universe, and they demand more in their stories. In particular, they want stories that show not only how the future will be similar to the past, but also how it will be different—for different it surely will be. The differences are developing faster than ever, and it's more important than ever for us to think about what they might be *before* they sneak up on us and catch us as unawares as people who were shocked by Dolly the sheep.

That is where I see the real significance of the fact that there were astronauts at that science fiction convention, and that *Analog* is a staple in the library of the International Space Station. It isn't just that astronauts and space stations are now parts of the real world, instead of just imaginings in stories. Even more important, I think, is that astronauts, who once dwelt only in the pages of fiction, are now not only living the futures imagined in the past, but still looking ahead to the futures that lie even farther out—and using science fiction as a vehicle for doing so.

The fact that so many concepts first explored here have already become parts of our real world does not mean that there's nothing more for science fiction to do. It just means that it now has to look still farther ahead; and in doing so, it will continue to help shape the futures that we get. Yes, it has done that in the past; things like the space program and the internet owe their existence in considerable measure to the fact that a bunch of young people in past decades read stories and thought, "Yes, that could really happen. I could help make it happen!"

And they did.

Or, in the case of things like global warming and overpopulation and mass extinctions,

"That's going to be a real problem. How can I help head it off? How can I make people care?"

And yes, I said "futures," not "future," a few paragraphs back. Fred Pohl, in the observation I quoted earlier, referred to the fact that there are many possible directions the future could take, but there are also multiple futures in another sense. The immediate future will evolve into a different one a little later, and so on *ad infinitum*. I always have to laugh when I hear somebody say something like, "The _____ of the Future" or even "The _____ of the Twenty-first Century!" If you look back at how different the end of the Twentieth was from the beginning, and consider how much faster things are changing now, it's ludicrous to believe that much of anything will be characteristic of the Twenty-first Century as a whole.

That's where the challenge, and future, of *Analog* lies. The fact that so many of our imaginings have become part of our everyday world is gratifying, but it's not the end of anything. Already we can see future problems and potentials arising from our having come this far, and we need to be thinking about those.

And no doubt, there will be brand new ones—new discoveries and surprises—that we can't anticipate now. A century ago, relativity and quantum mechanics revolutionized our understanding of the physical universe in completely surprising ways. Much more recently, discoveries about stem cells and epigenetics have had similar effects on biology. By definition, we can't predict the surprises, the truly fundamental breakthroughs, but we would do well to try to imagine and think about them anyway.

Astounding/Analog, more consistently than any other magazine, has tried to do this in an imaginative yet realistic way. In doing so, its first thousand issues have been, for many of us, a very important part of how we made it from where we started to where we are now. I look forward to its continuing to do so far into the future.

And I can't help wondering: What professions that haven't even been invented yet will be represented at the Worldcon in another twenty or thirty years? ■

The Wormhole War

Richard A. Lovett

It just happened to be Zeke Schlachter's bad luck to be command leader for the Advanced Explorer the day the wormhole blew up.

As far as he could tell, he hadn't done anything wrong. He hadn't done anything, in fact, unless you counted checking the telemetry, which had been absolutely nominal. Then, without warning, the view out the far end of the wormhole vanished.

For half a heartbeat, he thought he'd just lost the feed. That happened all the time at his cabin above Big Bear when he couldn't resist checking in at work, even if he'd promised his wife that this weekend really, truly would be a holiday. All those trees and mountains interfered with reception—which, Trina would gently remind him, was half the *reason* for having a cabin up there among them.

But this was Pasadena, not Big Bear. And while the Earthside end of the wormhole was actually beneath an Alp some eight thousand kilometers away, *that* connection was about as reliable they get. Reliable enough it was hard to imagine anything short of an asteroid strike or nuclear blast taking it down.

Which meant the wormhole really was gone.

Perhaps the glitch had occurred in Switzerland, and the folks there would take the heat. Perhaps. More likely, it had happened at Zeke's end—currently fifty-two light-years off in the direction of the constellation Apus (which, he'd had to admit the first time he talked to the press, he too had never heard of before it was picked for the world's first interstellar probe).

At the moment, the only thing Zeke was sure of was wishing he'd not volunteered for this shift. Normally, Saturdays were for his daughter's cross-country races. She'd just made varsity and had been happily tearing up the local turf until she'd sprained an ankle in practice. With no race to attend, Zeke had offered to take Liu-Wen's shift under the theory there's nothing better than banking favors with a colleague. If Christa hadn't sprained her ankle (or Trina had been free for a weekend at Big Bear), it would be Liu-Wen here today, gaping at the command screen and trying to figure out what to do next.

If, if, if. Like the twin poles of the wormhole, life had its balances. Zeke's bad break was Liu-Wen's lucky one.

* * *

As long as he'd taken the shift, Zeke had added a press briefing . . . not that there'd been much to report. Briefings had become part of his job soon after he'd made everyone laugh by admitting he didn't know where Apus was. "South somewhere," he'd added, with a vague wave of his hand. "To see it, you need to go somewhere like Chile. Or Tahiti. I keep telling them they need to send me to Tahiti, but for some reason, they never do."

The press loved him.

"We're still too far away to see Gaia 205c," he'd been saying this time, thinking someone really needed to come up with a better name for the most Earthlike world yet found within a hundred light years. It had water, an ozone signature, and a rotation period recently confirmed as seventeen hours. All it lacked was a name.

"But looking through the wormhole," he continued, "we can see that its sun appears distinctly brighter than last time I talked to you." He'd split the screen to show the older image. "What you can't see is that the rate of approach is slowing because we're already magneto-braking against the interstellar medium—hard enough, I might add, that if you wanted to get a little thinner, the g-forces on the other side might do the trick . . . though probably not the way you'd want."

Again he'd gotten the laugh. In a previous briefing, he'd explained how they could dilate the wormhole from pea-sized to big enough to steer to a soft landing on Gaia 205c, where the folks in Switzerland hoped to send through sensors, robotic rovers, and ultimately, people.

And then, poof, the dream was gone.

What do you do when you lose a twenty-billion-dollar probe? Figuring out who to fire was the administrator's job. Zeke's was simpler: Don't panic.

The good news was that twenty billion dollars was only a few times more than the Titan blimp that had been his prior command. In fact, in yet another press conference, Zeke had managed to voice the dual concepts of "only" and "twenty billion dollars" with such a straight face that he'd even persuaded himself that the Advanced Explorer was cheap. "Look at it this way," he'd said. "We're getting something close to three hundred miles to

the penny. That's like going from New York to London for twelve cents. Where else can you get a bargain like that? And once we arrive, we can send astronauts back and forth virtually for free."

More difficult had been explaining the concept of using relativistic wormholes for space exploration.

"You know how they say that what happens in Vegas stays in Vegas?" he'd begun. "Well, what happens on Earth stays on Earth. The outbound mouth of the wormhole has only been on its way for a few months, and from our point of view it's still somewhere in the Oort Cloud. But what happens inside it is happening at nearly the speed of light, and thanks to a guy named Einstein, that means that from *its* point of view, time is compressed. As I'm speaking, it's now off into our future by"—he'd glanced at a readout—"forty-eight years, two months, five days, six hours, and twenty . . . thirty . . . forty . . . fifty . . . minutes. Give or take a bit."

He'd paused for the laughter to settle. "What this means is that looking through the wormhole—or when the time comes, stepping through it—is like having traveled with it at 99.9-whatever percent the speed of light. The moment you step through, you wind up at the point someone riding with it would have reached."

What that currently meant was that from Earth's point of view, Christa would be a grandmother by the time the Advanced Explorer reached the point where it had been destroyed. But from the wormhole's point of view, whatever had gone wrong wasn't happening two generations in the future. It was happening now.

Normally, when a spacecraft dies it's because a critical component picks that moment to pack it in. That's what happened to the Titan Rambler when its mini-dirigible had sprung a leak, and the airship settled to final immobility on the slopes of Titan's tallest peak, ironically named Mount Doom.

But there was no way the demise of the Titan Rambler had been Zeke's fault. Gasbags exist to spring leaks. Who ever heard of a balloon that didn't eventually come back down?

This was a wormhole. It had no mechanical parts to break, no way of springing a leak. It

was nothing but a pinch of folded space encapsulated in enough mass for one end to be blasted at hyper-relativistic speed out of a particle accelerator while the other remained safe in one of the old military tunnels that once helped make Switzerland a nation no one dared invade.

Most likely, the wormhole had hit something, even though it was in interstellar space, far from its destination. The chances of such a collision were almost vanishingly small but worries about such things were why the Swiss had insisted the Earthside mouth be stored in one of those deep-mountain tunnels. Just to start with, nobody wanted to be anywhere near the Earthside end if Zeke's team piloted it too close Gaia 205c's star and accidentally scooped up a million-kilometer needle of superheated plasma.

What happens when you lose a twenty-billion-dollar probe? One answer is that your thought processes go into overdrive. Zeke's flashed from shock to incredulity to despair to physics fast enough that when he later watched his reactions on the press conference video, it all seemed instantaneous.

What made the Advanced Explorer expensive wasn't the cost of creating a wormhole. It was the energy involved in accelerating the traveling mouth to relativistic speeds. And exotic as it was, wormhole physics still obeyed the fundamental rules, one of which was conservation of energy.

A lot of energy now had to have gone somewhere. A small fraction would be the energy invested in creating the wormhole. But most of it would be the traveling end's kinetic energy, which Jake had once been told was enough to send a million-ton payload to Mars and back . . . twice.

Switzerland might be in for an unpleasant surprise.

Zeke lived in Southern California. He knew all about unpleasant surprises. When the San Bernardino shock hit, back when he was in grad school, his first intimation something was wrong had been waking in the middle of the night feeling as though a giant fist had slammed into him from beneath, launching him from bed to floor in a tangle of sheets, blankets, and bruises. He had no idea how to convert the wormhole's energy into TNT

kilotons, but if even half of it fed back through the Earthside mouth, it might be a lot.

"Earthquake!" he yelled. "If you're in Switzerland, batten down the hatches and hang on!"

What do you do when you lose a twenty-billion-dollar probe? Part of the answer was simple: retrace your steps trying to find out what you'd done wrong.

Back in his grad school days, he'd gotten lost once coming down from a hike on one of the peaks above Big Bear and had spent hours blundering around the woods, trying to find his car. The moment he finally regained his bearings, he'd dashed back up to the place where he'd gone off course, hoping to figure out how he'd lost the trail. He'd figured it was what any sane person would do, but when he told his friends, they thought he was crazy. Sane people would thank their lucky stars and go home. Why risk getting lost all over again? For that matter, why highlight your own stupidity?

What Zeke had found was a spot where going up the mountain, the route had been obvious. But coming back down there'd been a creek bed that looked like the trail, while the trail itself was a faint tread over bare, rocky ground.

Dumping his pack, he'd gathered stones to build a string of cairns to alert future hikers to the proper route. As he was finishing, another hiker approached, heading upward.

"Watch out," Zeke had said, gesturing to the creek bed. "Coming down, I thought that was the trail."

"Yeah," the other guy said. "The first time I did this hike, I made the same mistake. I spent all night down there. Damn near froze to death." He glanced at the cairns. "Good move. I should have thought of that."

But now, Zeke couldn't find a way to build cairns for future wormhole drivers. Whatever the Advanced Explorer had run into wasn't like Zeke's faint-but-visible-when-you-knew-where-to-look trail. This had been invisible to all instruments, even with the most advanced signal processing. The only anomaly was a small fluctuation in the wormhole's energy signature, picoseconds before its demise. But when Zeke pointed it out, his superiors shrugged it off as simply the first sign that the

wormhole was destabilizing. Effect, not cause. Useless information at its most useless.

To his surprise, Zeke kept his job. Liu-Wen didn't. He wondered if he should feel guilty, but if there was a logic to scapegoating, he'd never understood it. As best he could figure, his earthquake warning had made him something of a hero. The shock had hit at magnitude 6.1—large enough that nobody was ever going to be able to dig into those tunnels to find additional data to confirm his picosecond power fluctuation, but small enough that by the time it reached Lucerne, fifty miles and thirty seismic-wave seconds away, its power had abated considerably.

Zeke wasn't sure his warning had actually saved anyone's life, but the fact that it could have was enough not only to save his job but also get him promoted.

"Don't worry," Liu-Wen said. "I turned down three academic positions to get this job. Plenty of people will still want me. Besides, I was in this for the fun of piloting a wormhole. It's going to be a while before anyone gets a second chance at that."

A while turned out to be five years. Even then, the Advanced Explorer 2 went out with significantly lower energy than the AE-1. Partly that was to cut costs—only ten billion dollars this time—but it also made sure that if this wormhole met the same fate, there was only enough power for a magnitude 5 earthquake: not enough to endanger the citizens of Lucerne, especially if the Earthside end was moved to an even more remote tunnel.

By the time the new probe was approved, Christa was in college, though as a red-shirt freshman, she had no cross-country meets for Zeke to attend. By the time it got close to the point where the AE-1 had been lost, she was well into her junior year.

There was no real reason to expect any particularly large risk of hitting anything at the same distance at which the AE-1 had died. Launch trajectories aren't perfect, while rogue planets are small, and move. The chances of hitting the same thing twice in a row were less than those of hitting a gnat with a BB at a hundred yards' range. Still, as the distance from Earth mounted, days off were cancelled. Shifts were doubled. Christa had a shot at the

conference championship, but there was no way Zeke could go. She and Trina understood, but he felt wretched. Whatever the AE-1 had hit, the chances of the AE-2 hitting the same thing were effectively zero.

Which meant that when it happened again—five light-years early, to boot—Zeke was caught off guard.

Briefly, he thought the timing was weird. It was almost as though whatever had taken out the AE-1 was coming toward Earth at more or less the speed of light. But how could anything big enough to be hit not once but twice travel that fast?

Maybe it was coincidence. Maybe wormholes had limited range, losing stability somewhere around fifty light years. The only real data were the same picosecond power fluctuations he'd seen before. Those, plus another explosion in Switzerland and billions more dollars down the drain.

Nobody promoted Zeke this time. But neither did they fire anyone.

Instead, Trina got cancer.

The doctors found it by accident. Literally. A trip-and-fall, hiking (ironically) the trail where Zeke had gotten lost. The trail where his cairns still stood, maintained over the years by an entire generation of new hikers: a warning propagated into the future, one replaced stone at a time.

It started as nothing worse than a broken ankle. A call for help, an X-ray, a splint. About as normal for a hiking accident as the wormhole telemetry up until the moment disaster struck.

This disaster took the form of an odd shadow at the edge of the X-ray, halfway up her tibia. *No problem*, the docs said, *we caught it early. Lucky thing she fell.*

Except that nothing after that was lucky. Surgery, radiation, chemotherapy, amputation, killer stem cells, activated leucocytes—each began promising, then fizzled. Until, three years later, one of the twin lights of Zeke's life was extinguished.

The only good thing was that both hadn't gone out. Christa was now in grad school, following her father's lead into astrophysics, though her interests turned more toward theory than the practical disciplines that had always caught his interest. Unfortunately for

him, she'd wound up at the University of Melbourne—which, in another irony, meant she was the first in the family to actually lay eyes on the constellation Apus.

Meanwhile, Zeke took an extended leave of absence, convincing his superiors to bring back Liu-Wen as his interim replacement. Not that he turned out to have done her a favor. Moving with surprising speed, the folks in Switzerland launched not one, but four more wormholes. The idea was that they'd travel in pairs, with the pairs going in slightly different directions and one member of each pair trailing the other by a few light hours. That way, if either of the lead wormholes vanished, the second ones could watch it happen and possibly even send back samples of the residues when they passed through them.

Launch energy was lower than ever, though with four wormholes, the cost was still substantial. Luckily, much of the funding came from the high-energy physicists' budget, for whom mysteriously failed experiments seemed to produce more funding rather than less—a process Zeke envied. But the space budget also kicked in a substantial amount. Low-energy wormholes could be the key to colonizing Mars, the Moon, the asteroids, and the rest of the Solar System, but only if they weren't prone to blowing up.

What happened was that the two leading wormholes in each pair blew within days of each other, well before either got as far as the AE-1 or AE-2. The trailing wormholes saw nothing more than pinpricks of light that might (or might not) have been the blasts of the leading ones. Neither got far enough to sample the residues. Shortly before they got there, both of them also blew.

Zeke sympathized, but at the time he had other concerns. Pinches of folded space-time could be replaced. Trina couldn't. Zeke's parents had just hit their forty-seventh anniversary and were still going strong. He'd never dreamed his own marriage would be cut so short.

Six months later, Zeke found himself in a bar. He'd been doing more of that than he should, but with Christa still in Australia there wasn't much else other than burying himself in work, which he'd been avoiding.

But at heart he was still a scientist. During his leave, in fact, he'd been reading up on some of the more arcane aspects of wormhole theory, hoping to find a clue.

What could the wormholes have been hitting? Or did they really have a range limit that the physicists had never figured out? In theory, it ought to be possible to send a wormhole across the Galaxy. To other galaxies, in fact, or even the edge of the Universe if you had a powerful enough accelerator. Not to mention that the range at which they were dying seemed to be constricting. Would there come a time when it wouldn't even be possible to get one out of the Solar System? At the current rate at which the range had been declining, Zeke might even live long enough to see that happen. Christa almost certainly would.

Idly, he pushed his drink aside and spilled a handful of change onto the bar top. Quarters gave him the two ends of the AE-1: big coins for the wormhole that carried the most power. Dimes for the AE-2, pennies for the AEs 3 through 6.

Not needing an entire stack of coins to mark Earth, he settled for parking a dime and a penny on the AE-1's quarter, then pushed the unneeded coins aside to give him room to slide around the ones marking the wormholes' outbound ends. A moment later, he realized that the guy sitting next to him was watching intently. "Just thinking about physics," Zeke said. Only later did it cross his mind that it was the type of comment that in some bars would get you in trouble. But in the umbra of Southern California's high-tech culture it merely marked you as somewhere on the continuum between odd and brilliant.

"Okay," the guy said. "But if you're trying to work out pool shots, you have to account for spin."

Zeke relaxed. "True. But these are wormholes."

"Like the things that keep blowing up? Waste of money, if you ask me."

"Maybe. I'm the guy who blew up the first two."

"No kidding." His companion held out his hand. "Cole Livingston." There was a bit of a slur to his voice. "No offense intended. I just don't like my taxes going into blowing up useless stuff. What's each one of those cost us? A hundred bucks a taxpayer? That's a lot of beer

money down the drain. But, as I said, no offense intended.”

“None taken. What are you drinking? I’ll buy you back one of those beers.”

Livingston laughed. “I’m never one to turn down a free drink. What are you doing with all those coins?”

That led to a somewhat beery description of wormhole travel, as Zeke explained the difference between the quarters, dimes, and pennies. Not a bad choice in coinage, when he thought about it, since that was about the ratio of the various missions’ costs.

Somewhere along the line, Zeke explained the dream: being able to hop instantly from one end of a wormhole to the other, even if it was a hundred or more years into the future thanks to the wormhole’s relativistic flight.

Livingston thought about that a moment. “So, you get to the other end no older, but a century in the future?”

“Give or take a bit.”

“What happens when you come home?”

“You wind back when you started, plus however long you stay at the other end. If you spend a year exploring, you come back a year after you left.”

“Cool.” There was a pause, then Livingston plucked a nickel from Zeke’s unused change. “What if you went to the other end and shot a wormhole back to Earth?” He placed the nickel on the quarter marking the outbound end of the AE-1, then put another on the Earth-side stack. “If you went out through the quarters and back through the nickels, would you arrive on Earth two hundred years in the future?”

“What are you, a physicist or something?”

“Heavens, no. I’m a film editor. Or used to be. These days it’s more and more a computer jock’s field.” He took a pull of his beer. “I’m about half-retired now.”

Only in California, Zeke thought. “Anything I might have seen?”

“It depends on how much TV you’ve watched.” Livingston finished his beer and Zeke waved for another. “Part of the job is to assemble a rough cut that makes as much sense as possible—which with some scripts, I have to tell you, isn’t as easy as it might be. I work mostly with cop shows, and when they give me enough time I try to ask ‘what if’ questions and look for ways to fix the story

line before it’s too late.” The beer arrived, and Livingston took a big draught. “Sometimes that’s not possible, but it breeds a certain way of thinking.”

“So you’re also interested in time travel?”

He laughed. “Sure. Who wouldn’t be? But that’s not the type of story line I work with. The men in my family tend to die young. Cancer. Diabetes. Bad cholesterol.” He patted his paunch. “Obesity. Cirrhosis, too, if I’m not careful. I’ve probably got the same bad genetics, so yeah, the first thing I think is: could I go out through your wormhole and back through mine to a future where all of that can be cured? *That* would be worth all those wasted beers.”

“Only if you’re willing to leave behind everyone you know and trust the future to actually care about you.”

Another laugh, with less humor this time. “Yeah. I’d have to set up a trust fund. And I like my job, so I’d want to come back.” He stared into his beer. “At least I did like it, back when people had enough budget to *care* about the final product.” His mood brightened. “Besides, if I wound up in a place like this two hundred years from now, what the hell crazy BS would we be talking about? Laser spinomics of the Higgs boson? Don’t look so shocked. You should see the tech-babble some of the writers produce, even for cop shows. Especially when they need the crime-scene techs to pull some rabbit out of a hat. . . . But that’s not the point. A couple hundred years from now, you’d be talking like something out of the worst of those scripts and I’d be nodding as though I knew what it all meant. I think I’d rather live a shorter life in my own time.”

Livingston returned to his beer, but Zeke was no longer interested in his own. Unintentionally, his companion had painted the choice that loomed before him: spend ever more time in places like this or go back to work.

Zeke stared again at the coins, now including the nickels. Earth to Gaia 205c. Gaia 205c to Earth. A two-hundred-year leap. It was a nice metaphor for his last six months. Stay here immersed in his grief, or leap into the future, albeit in a more conventional manner than jumping through a wormhole.

Not that there was much doubt which he would choose. Christa would care. And in her

last weeks, Trina had tried to extract a promise that he wouldn't simply pine away. *I'll try*, was all he'd been able to say. *Just don't ask me to pretend that life will ever be the same.*

Livingston was again watching him. "So if I went to the future and got my genes fixed," he asked, "would I actually be stuck there shooting the shit about bosons with someone like you? Or could I just get back in the wormhole and come home? For that matter, if my great-great grandkids wanted to meet me, could they just jump in their own wormholes and go out to Krypton, Tatooine, or whatever the hell it's called—"

"Gaia 205c."

"You gotta be kidding me. *Anyway*, could they just go out from their future to Gaia Whatsits, jump in you guys' wormhole—if you ever get one that, forgive me, doesn't blow up—and come back and tell me to shape up?" He snorted. "Not that I'm sure I'd want them to. I mean, if I could go back and tell my father what I thought of him, I'd be all for it. But if someone from the future came back to tell *me*? Shit. I might rather keep all that beer money, after all."

"Don't worry, it wouldn't work."

"Why not?"

"Because it's one thing to go off into a wormhole that's a hundred light-years away and a hundred years in the future. You could do the same in a spaceship if you had one that went fast enough. And it's no problem coming back home through that wormhole, because you're not truly bringing anything back from the future—only from a great distance. It's kind of like crossing the International Date Line. The numbers change but nothing real is affected."

"What would happen if you tried it my way?"

"I don't know. The Universe as we know it depends on causality. If you could do something like that, you might be able to make time run backward or forward at will."

That was an odd thought. Would it mean he'd be able to watch Trina be uncremated, rise from the dead, shed her cancer, and return to her former health? Except that then, Christa would eventually be unborn. Would he even remember the joy of parenthood? Or could yet another against-the-grain-of-time wormhole trip reverse the process again and

let him relive the good days all over again . . . only to then rewind them and play them back over and over and over?

Weird stuff, and yet another reason the laws of causality couldn't be changed. Unless, of course, they could be, and someone somewhere, sometime, had figured out how to do it, trapping the rest of the Universe in an endless loop of back-and-forth, like that old movie *Groundhog Day* but without benefit of being able to remember anything and learn from your mistakes.

That way lay madness. All of recorded history, plus billions of years of prehistory revealed by geology and astronomy said time ran in only one direction. Trina was dead and not coming back.

"But that can't be done," he finished. "It would create a Universe very different from what we know, which means that nobody, now or in the future, has ever managed to do it." But even as he was saying it, he was staring at Livingston's nickels and the assortment of shoved-aside coins from which they'd come.

"Shit," he said. "I think we might be in trouble. Want another beer?"

"Technically, it isn't called a time loop, but a closed time-like curve," Sébastien Dubois said when Zeke phoned him up the next morning. "But you basically have the idea. The presumption is that attempting to create one won't work, but that has been dogma for so long that nobody really thinks much about it. Are you suggesting we actually give it a try?"

"Yes." Zeke explained why. "But don't tell anyone or I'll get laughed off the planet."

"True enough." Dubois paused, and Zeke could imagine him removing his glasses to rub his eyes. "But the experiment is interesting and the energies low enough that there is really not much chance of anyone getting hurt. It is one of those fundamental questions that we now have a chance to answer, and I think I can sell it. Do you want in on the proposal?"

Zeke didn't even have to think about it. It was the bar-future versus the Christa-future. "Yes. If possible, I'd like to drive the thing."

"I cannot think of anyone with better credentials. It really is an interesting idea. As I said, a truly fundamental question that nobody has ever put to the test."

* * *

Unlike the NASA missions Zeke was used to, this grant came quickly out of the physics budget. What's a hundred million dollars in a field where particle accelerators can cost a hundred times as much?

The plan was simple enough: make a wormhole and launch one of its mouths on a low-energy course, just fast enough for a tiny bit of time dilation. Then bring it back to Earth and put it and the Earthside mouth close enough together that you could send signals between them, forward in time in one direction, backward in the other. If it worked, backward time travel was possible. Causality didn't exist, and people could, in theory, send themselves stock tips from the future. If it didn't? Well, that was why, while the traveling mouth of the wormhole was on a slow, looping trajectory from Earth, around the Sun, to Jupiter and back again, the Earthside end was shipped to Kazakhstan, where the former Soviet Union had a history of blowing things up, and there was a lot of empty land where nobody much cared.

Two years later, the wormhole landed, intact. No surprise, because during its entire transit, the time dilation had been less than a microsecond, which meant that as long as the traveling end came down more than three hundred meters from the Earthside end, there was no possibility of a time loop.

The next step was to mount one end on a trolley and inch it closer and closer to the other, all the while peering through both ends with all the equipment at Dubois' disposal.

The result was quick and confirmed the theory to perfection. The moment the two mouths of the wormhole got within a light-microsecond of each other, they both vanished in a bang—though this time, the explosion merely excavated a pair of twenty-foot craters, barely registering on nearby seismometers.

For a mere one hundred million dollars, Dubois and his physicists had confirmed that the Universe abhorred time paradoxes. But Zeke had gotten something better. What he'd been looking for were power fluctuations in the final millimeters before the wormhole mouths got close enough to create a loop—and what he saw was exactly what he'd found with the AE-1.

That meant that it and its progeny had died because somehow they'd created a loop. The only question was whether anyone would believe him.

"So you're telling us that someone in the future is trying to build a time machine?"

The phone call had come via a secretary who identified his boss as the chief assistant to the president's science advisor, then placed Zeke on hold for five minutes while the assistant advisor was advised that Zeke had actually answered his phone. At times like this, Zeke was very happy he'd never gone into politics. But at least those who had were seeing his work as more than simply budgetary red ink.

"Not quite," he said. The assistant advisor's name, he vaguely recalled by the time he'd finally gotten off hold, was something Eastern European. Radić. Zita Radić. Dr. Zita Radić. "If anyone is—or should I say will be—trying to do that, they'll just blow up their own equipment and presumably won't keep doing it, over and over."

He paused, trying to organize his thoughts. If English had a tense for this, he didn't know it. Future actions viewed as though they'd already happened. The idea was simple, the wording not.

"More to the point, our causality experiment in Kazakhstan was pretty conclusive. Sébastien Dubois and I are in the process of writing it up for *Science* or *Nature*, which means people in the future will already know backward time travel doesn't work."

"So instead, you're saying that someone in our own time frame is making wormholes that create time loops and, for lack of a better term, using them to muck up our own wormholes? The Europeans, Russians, and Japanese have the capability, but they're working with us. The Indo-Chinese probably have it too, but economic sabotage on that scale would have nasty repercussions. I can't see them risking it."

"I agree." Zeke would only have Radić's attention for a few minutes, so he needed to cut to the chase. "I think we're interfering with a wormhole network a lot farther away than China."

There was only the barest hesitation in her voice. "I take it this isn't someone we already know." The tone was matter-of-fact, almost as though they were discussing the weather.

In for a penny . . . "Correct."

"Are they on Gaia 205c?"

"I have no idea."

"But what's happening, you're saying, is that we're shooting wormholes at someone else who just happens to be shooting them at us at the same time? Isn't that a bit of a coincidence?"

"It would be if that were the only way it could happen." Zeke groped for an analogy. "But it can also be like interlacing your fingers: the fingers go well past each other before your hands clasp. To make a loop, all that has to happen is for our wormhole to penetrate deeply enough into someone else's system that it's possible to go from one of their wormholes to ours, then through it backward in time to Earth, and finally back into their system by some speed-of-light route that gets you there before you left. The more complex their system is, the easier this would be."

"So you think we created a path by which Battlestar Gaia could go through a loop into its own past, in the process producing all kinds of wibbly-wobbly timey-wimey stuff the laws of physics won't tolerate?"

Zeke almost laughed. Maybe Radić wasn't so bad after all. But there had been nothing joking in her tone. "Sort of. All that's needed is for it to be possible to send a radio signal, light wave, X-ray, or anything else around a loop backward in time. What our Kazakhstan experiment showed is that the moment this can occur, the wormhole collapses."

"Does that mean there are alien spies among us receiving these signals and relaying them back?"

"No." Maybe Radić actually wasn't anything more than a political idiot, after all. "I'm talking about physics. Nobody actually has to be trying to produce a loop; all that matters is that it's *possible*."

"Good," Radić's voice relaxed, catching him by surprise. "What you've been saying made sense but you wouldn't believe how many UFO theories I've had to deal with." She paused. "I think it might be a good idea for you to come to D.C. at your earliest convenience. When can you schedule it?"

"Tomorrow, if you want." It was Zeke's turn to hesitate. "So long as the ticket doesn't come out of my budget. The accountants might not like it."

Radić laughed. "We'll cover it. But you don't have to drop everything. Whatever this is has been going on for years."

"True. But from the best I've been able to figure"—which started with coins on a bar top, but Zeke wasn't going to say that part—"whoever we've interfered with is doing more than simply rebuilding their system. They've figured out where we are, and are coming our way. Fast. I don't know how quickly they can get here, but they're definitely on the offensive. Each day we hesitate is a day closer they get."

What do you do if entities unknown shoot multi-billion-dollar wormholes at you faster than you can get your own into their territory? Build more and fire them back even faster, the newly formed Planetary Defense Commission concluded. Going to Gaia 205c was now out of the question. The goal was to keep Gaia 205c from coming to Earth.

For the next several years, Zeke, Liu-Wen, and a growing cadre of others guided wormholes toward the stars, as Fermilab, Brookhaven, and even the Indo-Chinese were pressed into service producing ever more of them. And since nobody wanted magnitude 6 earthquakes in their backyard, even more money went into figuring out how to make less-massive wormholes that would produce proportionally less-powerful explosions.

Some wormholes went toward Gaia 205c. Some went elsewhere, lest the Gaians be trying to sneak up from behind (however "behind" might be defined in three dimensions). But the Gaians were slowly, inexorably winning. With each salvo, the range at which Earth's wormholes blew up shrank.

Heaven alone knew how many of the aliens' wormholes were slipping through or around Earth's defenses, closing in at nearly the speed of light. Hell alone knew what would emerge from them when they got close enough to strike. Planet-buster bombs? Star-snuffer missiles? Biotech weapons to extinguish all life on Earth? Or an invitation to join some Galactic Confederation, coupled with a polite request to quit interfering with its wormholes?

Zeke had discussed exactly these questions in his first face-to-face with Radić.

She'd been surprisingly young, more like an aide than a senior advisor. Trim and petite,

with medium-short red-blond hair flipped playfully over one eyebrow. Not at all what he was expecting.

Her doctorate was in biochemistry, but the job that had brought her to prominence was as news editor for a major journal. "It's the closest you can get to being a doctor of everything," she'd said. "Which is appropriate, I suppose, since we're dealing with something akin to time travel."

Unlike the phone call, this time there'd been no power games. Instead, he'd been ushered immediately to the inner sanctum. Had he passed a test? Or had her prior behavior been a habit: a compensation for youth and beauty that caused everyone to underestimate her? Trina had been a hydrogeologist. Looking too feminine, she'd found, was a career impediment. Zeke would never forget how he'd felt when she hacked off the mane of wavy black hair he loved and replaced it with curls that made her look a decade older. *I had no choice*, she'd said. *People don't expect a young-looking woman to know anything.*

He also noticed that she had no ring.

Zeke's friends would have applauded him for even seeing that, telling him it was a sign he was moving on—just as his bar-top coin-shoving had been a sign he was again ready for work. But not all parts of life move on at the same pace . . . or even move on at all. What Radić's non-ring sparked in him wasn't interest, but a pang of loss. Nobody could replace Trina. Nobody ever would.

She'd also been doing a lot of research while Zeke was traveling, because she now talked knowingly about wormholes and took the likelihood of alien contact very seriously. In her news reporting days, she must have been one hell of an editor.

"How do we know they're not friendly?" Zeke asked a few minutes into their conversation.

"We don't. But neither can we risk that they are. Look at it from their point of view. They were minding their own business until we shot a wormhole out there that most likely trashed their interstellar transport system. It would be like someone grounding all the airplanes on Earth or shutting down the internet. Maybe worse, because we'd still have roads, ships, and radio. Who knows how dependent they are on wormholes? They might use them

to ship food from one planet to another." She brushed her hair away from her eyes. "Sure, we didn't intend to do it. But what did we do next? We hit them again with the AE-2. And then again and again with AEs 3 through 6. How would you feel if people you'd never heard of kept trying to cut you off from Australia?"

Radić's smile was vaguely apologetic.

"Yeah, I realize that you probably want your private life to be private. But at the clearance level we're about to give you, that will never again happen. I probably know more about your daughter than you do." She laughed, and that was when Zeke decided the more relaxed Radić was the real one. The one he might once have noticed in a way his friends would approve of.

"But don't worry," she continued. "Christa's a great kid, better than even you might realize. My point is simply that if I were the aliens, I'd hate us for how we've interfered with their lives." She brushed again at the hair. "But from our point of view, it's now a classic case of having a tiger by the tail. We didn't intend to grab on, but the tiger is charging toward us, and keeping alive for as long as possible has to be top priority."

She paused. "Okay, that was a mixed metaphor. But the point is, it's too late to let go. Maybe we can establish a perimeter we can hold indefinitely. Maybe we can't. But we can at least buy time. If you're an evolutionary biologist, stalling and hoping for a miracle are probably hard-wired into our genes."

Since then, as Radić rose from assistant to the advisor to the actual advisor, she and Zeke had talked dozens of times, never again with a trace of power games, but neither with either of them acquiring a ring. He'd never had the nerve to ask about her private life, but if it was the impending alien invasion that made her reluctant to commit to a long-term future, she wasn't the only one. Globally, not only was the birth rate down, but so too was the marriage rate. "Normal" lives aren't normal when the end of the world might be only a few decades away.

For Zeke, the reasons for remaining single were different. He wouldn't want more kids anyway. Not only was he a bit old, but he already had a daughter. And whatever his

friends might advise, the wormhole project was the only replacement spouse he needed. Or so he said. In the lonely nights of 3 A.M., there were times he wondered if that was simply an excuse.

But if it was an excuse, it made perfect sense when the end of the world drew closer each year. No matter how many wormholes Zeke's team threw at the aliens, nothing seemed to slow their advance. Which made no sense whatsoever.

Earthquake considerations limited the speed of the Earth's best wormholes to 99.999 percent the speed of light. But even if the aliens could launch at 99.9999999 percent, all those extra nines produced a mere five-minute-per-light-year difference in absolute speed. If that was the only advantage they had, it would take them six million years to draw even a single light-year closer to Earth. But each year, the Gaians—or whoever lay out in that direction—seemed to be drawing nearly another full light-year closer. They had to be doing *something* Zeke's team hadn't thought of.

By the time Zeke first believed he might have figured it out, Christa was a tenured prof at the University of Auckland who—like virtually every other high-end physicist or astronomer—had been pulled into the war effort. Zeke himself carried the rank of captain.

The first person he called was his old colleague Dubois, now lieutenant commander. "What would happen if you sent a wormhole though a wormhole?" he asked as soon as Dubois's face appeared on the screen.

"We thought of that a long time ago," Dubois said. "As best we can figure, nothing. You have a loop, but in terms of time shift you might as well walk around the block. Basically, the second wormhole—let us call it the 'inner' one—would pick up the time dilation of the outer one when it passed through, just as anything else would. Thus, no matter how you went around the loop you would end up right back where you started: the same as if there were only one wormhole. It would merely be an exercise in . . . how do you Americans put it? Spinning your wheels? It is no different from having a single wormhole."

"But what if you shot the new wormhole through at higher velocity than the first?"

"You would still gain nothing. Or almost nothing. The new wormhole would be significantly faster in relativistic terms, but they're still both going at nearly the speed of light. It would take days for them even to get as far apart as the Earth and Moon. I'm sorry, but you cannot leapfrog ahead in that manner. Not at any significant rate."

Frustration had always made Zeke tenacious—something Christa might have inherited during her cross-country racing days. Whatever the Gaians were doing had to be something on this order. Either that, or it involved unknown physics, and there was no way to match it.

"What about this?" he said. "Suppose, before sending it out through the first wormhole, you put one end of the new wormhole in a cyclotron and spun it up long enough to create a significant time differential? Then when you send it out through the first wormhole, it gets there with a different time differential than the first one had. Wouldn't that allow it to get deeper into alien space before it blows?"

"I'm sorry, my friend, but if you attempt that, the moment you get even a tiny time differential, the stationary end of the wormhole and the one in the cyclotron create a loop, just like the one we made in Kazakhstan. All you accomplish is blowing up your cyclotron. Wormholes have to be accelerated and released *quickly*. And even if you could come up with some kind of sleight-of-hand to avoid that problem, the moment your accelerated wormhole goes through the first wormhole, it instantly creates a loop." He spread his hands. "Again, ka-poof."

"Damn," Zeke's memory flashed to Cole Livingston and the future he wanted to visit but not stay in. Briefly, he wondered if the filmmaker was still alive. Perhaps Zeke should simply have stayed with him in the bar.

Then the stubbornness reemerged. "Unless they've got technology we haven't dreamed of, they've *got* to be doing something like this," he said. "Otherwise we'd both simply be shooting wormhole systems at each other that meet more or less in the middle until the cows come home." Or at least long enough for millions of years of evolution to replace his no-longer-likely

great-to-the-nth-grandchildren with something that might be more alien than the aliens. "Somehow, they keep beating us back."

Zeke stared at the tiles on his office ceiling. "Okay, try this. What we've been talking about is like a tube within a tube. But what if we could shut down the old wormhole just as the new one was emerging from it? Could we sort of merge the two into one so quickly there'd be no opportunity for backward time travel?"

There was a long pause. "I guess," Dubois said at last. "If we were quick enough. But what do we get for it?"

Zeke stared at the ceiling again. "Nothing, I guess." But then his mind ticked over. Tubes within tubes within tubes. "I was trying to come up with a way to change a wormhole's time differential," he said. His mind was spinning. "But that's not what we need. We need . . . aircraft carriers. Well, sort of. Platforms from which . . . through which . . . we can launch wave after wave of wormholes. No single wave has to be all that much faster than the one before—just fast enough that when it goes down it's far enough ahead that its launch platform survives."

He could feel the excitement returning. "I don't know exactly what the aliens are doing, but they've probably got primary, secondary, and even tertiary waves of wormholes. Maybe more. When they lose one, they instantly launch another, so that their attack front keeps closing in. It's like sending in one line of troops after another. When the first line gets mowed down, the next steps into its place. If you have enough troops and the enemy can't fire fast enough, you eventually win."

"That is a rather gruesome image."

"Yeah," Zeke said. Thankfully, all that was at stake at the moment were wormholes, not lives. "But I guarantee you that something like that is how they're doing it. Whenever they lose an advanced wormhole, they have another ready to replace it."

"So what is the countermove?"

"Build a lot more accelerators and fire off wormholes as fast as we can. High launch speed may not be as important as sheer numbers. And try to figure out how to do that wormhole-through-a-wormhole-through-a-wormhole trick. Maybe we can stalemate them, at least until one or the other of us goes

broke." Though if this turned into a protracted economic war, Earth was a single planet against what was probably an interstellar civilization. "How long do you think it might take them to decide it's not worth it?"

"I do not know. Back in the Middle Ages, my country had something called the Hundred Years' War."

"Ugh. How'd it turn out?"

"We won. Although it actually lasted a hundred and sixteen years, and between the war and the bubonic plague, parts of my country lost 75 percent of their populace. Plague might not be a threat today, but if we have to spend too much on defense, it will be hard to keep people from slipping back into starvation."

Time passed again. More wormholes were launched. More wormholes exploded. Dubois got a promotion to commander when his team figured out how to send wormholes through each other in exactly the way Zeke hoped for. But year-by-year, the Gaians drew closer.

Zeke felt old. And tired. When he'd been handed control of his first wormhole, the dream had been to explore, maybe see humans walk on another world. Possibly even to go there himself, though he'd never had the nerve to voice it to Trina. If wormholes really, truly worked, stepping through to Gaia 205c would have been no riskier than a trip to Switzerland.

But now all he was doing was trying to figure out how to keep someone else's wormholes at bay. And while Christa, recently promoted to lieutenant commander, had continued to move up the Planetary Defense ladder, there had been no grandchildren, and she was nearing the age where that would be increasingly unlikely. Like her father, she had married the Wormhole Corps.

At the moment, Zeke was on yet another telecom consult with the command staff, led by Radić—now risen to rear admiral, though Zeke wasn't sure how much clout the rank truly carried. The Wormhole Corps was a service for geeks, and nobody was about to put them in charge of actual weapons. Not that Zeke wanted anything that resembled a gun. So far, the fight had been more like the Cold War of his grandparents' youth than Dubois' century-long feud.

But more than ever, it was a war Earth was losing.

The current council had begun with a long discussion of the logistics of transporting wormhole mouths to sites where they could be held pending their inevitable detonations. Years before, after a few unfortunate incidents in Tibet, Saudi Arabia, and the Australian Outback, Planetary Defense had decided it was simpler just to drop the things onto the Antarctic ice, where presumably nobody could be harmed by even the biggest blasts. But in the past few days, one wormhole had detonated in a decommissioned transshipment facility frighteningly close to Auckland, while a ground blast in Antarctica nearly took out a plane carrying new wormholes to a supposedly unused quadrant. Zeke was frightened, the New Zealanders were angry, and everyone was unhappy that somehow at least two wormholes had been misplaced.

"So we're agreed that we've got a records problem and that we're lucky nobody was killed," Radić eventually said. "Captain Gupta and Commander Suramongkolwit have agreed to look into this and will report their findings back to me. But with all due respect to the New Zealanders—and that includes you, Zeke—this is not the most important issue before us."

The array of faces Zeke had been looking at disappeared, replaced by a three-dimensional projection of the routes of every wormhole ever launched, color-coded by date. In one direction, tracks stretched more or less forever. Wherever the aliens originally came from, it obviously wasn't that way. But in the other direction the display showed a red-yellow-green-blue anemone of ever-shortening tentacles.

With the advent of wormhole-through-wormhole countermeasures, the rate of constriction had slowed slightly—enough that Zeke might actually outlive the point when the anemone was squashed totally flat. But Christa's generation wouldn't. Perhaps that was why she'd decided against children. In her position would he really want to bring forth children who might never have children of their own? Who might never reach college or run in joyful abandon for cross-country glory?

The anemone's slowing rate of constriction, of course, was good news. But if you reversed the frame of reference, it hardly mattered.

Viewed that way, the shortening trajectories of Earth's wormholes hinted at invisible paths of alien swords extending ever closer to home—like Damocles', multiplied by thousands.

"They're still doing something we're not," Radić said. "Any thoughts?"

Over the years, she and Zeke had developed an increasing bond. In a different reality, he might truly have chosen to do the emotional work needed to start again. But in this reality, she was the admiral, and it was his job to break the silence.

"In part, one of their advantages has been that they've always reacted faster," he said. "Between the loss of the AE-1 and the launch of the AE-2, it took us five years to decide what to do, and in that time they got nearly five light-years closer. Every time we've stopped to think, they didn't."

"I agree." Zeke's com IDed the speaker as a lieutenant commander from the reunified Korea. "Maybe they've had fights like this before."

"Maybe," Zeke said. "Obviously they figured out what was happening a lot faster than we did." He paused. "But Rear Admiral Radić is right. They've sure as hell figured out something we haven't. Otherwise this would be a stalemate."

"Slow glass," Dubois said.

He and Zeke had discussed this before. The idea was that if you could create a material in which the speed of light was reduced to a crawl, you could encase the Earthside mouth of a wormhole in enough of it to make sure no time loop was possible until you broke the glass, presumably when the traveling mouth was deep in enemy territory. But other than the fact that nobody had ever created such a material, there was one problem.

"Neutrinos," Gupta said, beating Zeke to the punch. Apparently, Dubois had also discussed his idea with the Indo-Chinese. "Just because nobody has ever figured how to use them for communication doesn't mean it's impossible. They'd zip right through your slow glass and set up a loop."

"Perhaps," Dubois said, "but alternative ideas are a bit scarce."

"Yeah," Zeke said. "When this meeting was called, I spent some time pondering them." Actually, he'd gone back to Big Bear, said a

prayer for Trina, and hiked his mountain. The best ideas sometimes come from *not* trying to think.

"And?"

"How small can you make a wormhole?"

"Right now, or in theory?"

"Theory."

"In theory, I have no idea."

"Could you make it so small that nothing, not even a neutrino, could get through?"

"In theory, I doubt it. What you're talking about is something very close to a mathematical point. Basically, a singularity. But it might . . . *in theory* . . . be possible to create a wormhole with one end that's essentially a solid plug. Like a shuttered window that you could . . . *in theory* . . . open whenever you chose."

"Maybe that's what they're doing," Zeke said. "If we could do that, we could shoot these . . . shuttered . . . wormholes out as far as we want, open them whenever we want, and take down whatever alien wormholes happen to be in range at the time. Or we could use them as mines—opening and closing them randomly as they travel."

"Interesting." It was another of the Indo-Chinese delegation—a Captain Banerjee, who was presumably Gupta's superior. "Could we actually do it?"

"No idea," Dubois said.

"But if we could," Banerjee pressed, "might we indeed be able to get behind their lines and drive them back?"

"Maybe."

"Good," Radić said. "Our problem has always been that we keep thinking like explorers. But what we need to make are bombs. Things that can get deep into the enemy's system before they blow, taking out their reserves while our traditional defenses handle their front lines. Who was it who first said the best defense is a good offense?"

"Machiavelli," someone said, *sotto voce*. From the accent, it might have been the representative from New Zealand, but the voice was soft enough that Zeke's com didn't identify it. If Radić heard, she pretended not to.

Three weeks later, Radić, Zeke, and Dubois met again, this time in person: a brainstorming session, not an official strategy meeting.

It was Radić who'd called them together, and she was the one with the new idea. "That

closed-mouth wormhole stuff is great," she said, "but it involves new physics that might or might not work. And even if it does, we're still going at this like scientists, not warriors."

She rose and stared out her window—a vulnerability she'd never have showed outside her inner circle.

"Our history is in wanting to use wormholes to discover the Universe, which means we automatically think in terms of keeping one end at home, so we could, in theory, look through it." She was still staring at the Potomac. "But who needs to *look* through an artillery shell in flight." She turned back to Zeke and Dubois. "What if we sent *both* ends out toward the Gaians? Let them create a loop whenever they get close enough—without, I might add, having any need for anything to blow up here on Earth?"

"It wouldn't work," Dubois said. He smiled apologetically. "I realize that probably seems like my favorite phrase."

Radić's return smile was wry. "That's why you're here. What's wrong with it?"

"Two things. First, I have no idea how we could open a shuttered wormhole mouth from light-years away."

"That's not what I was talking about," Radić said. "Though if you could come up with a way to do it, it would make for an even more powerful bomb. I'm talking about conventional wormholes. The kind we've been using for years."

"Oh." It was the first time Zeke had seen Dubois caught that much off-guard. But he recovered quickly. "No difference. The other problem still remains: If we send out both ends, they wind up with the same time displacement. There is no loop, and when all is said and done, it would accomplish nothing. A very expensive nothing."

"Oh, that's easy to fix," Zeke said. "We just fire out one end, wait, then fire out the second. We could launch a huge wave of them, sending out the second ends whenever we choose."

"Sounds expensive," Radić said.

Zeke shrugged. "So's everything." He paused, wishing he had a bar top on which to slide around coins. "But not as much as you'd think. We'd want to send the first half of each wormhole out relatively slowly, so it doesn't get uncatchably far ahead. Then we send out

the second, fast enough to catch it at the range where we want to create a loop. Neither has to be super high-energy because we're creating time displacement the old-fashioned way, by storage."

Dubois snorted. "Sorry," he said, then laughed again. "A few generations ago there was a fad for 'time capsules' in which artifacts were preserved for future examination." His smile was apologetic. "I very nearly chose to study history instead of physics. What you are proposing is much like a time capsule . . . with a kick. Though maybe a library might be a better analogy."

"A library from which you can check out ever-better time bombs," Radić said. "Maybe we can finally take this battle to the Gaians, rather than waiting for them to bring it to us." It was her turn for the half-smile. "The ability to defeat the enemy means taking the offensive." She took one final look at the Potomac, then returned to her desk. "I've been smoothing feathers with the Indo-Chinese. In our last meeting, somebody said something about Machiavelli, and they've been telling me that Sun Tzu predated him on that 'best offense' advice by about two thousand years."

Suddenly Zeke felt the enthusiasm drain out of him. He didn't know much about Sun Tzu, but *Machiavelli* had been haunting his thoughts. Was that who he wanted humanity to be? Was it who *he* wanted to be? Only moments ago he'd been talking about barrage-waves of wormhole bombs, all the while using the word "we."

Radić's glance indicated she'd caught his mood shift, but she didn't say anything until Dubois was gone.

"What's wrong?"

"Not sure. Could we talk again before I go back to Pasadena?"

She checked her calendar. "I'm pretty busy, but I can do lunch tomorrow." Her lips turned up in the briefest of smiles, years draining from her face for a fleeting instant. "A bit like the old times, right? Back when we were just scientists. I don't know about you, but I've never quite figured out what it's supposed to feel like to be an officer, let alone an admiral."

"Yeah," Zeke said. "It's not what I imagined doing when I was in grad school." However many decades ago that had become.

Radić rose, still trim in a tailored business suit that briefly reminded Zeke of the alternative future that never could have been. "At least we don't have to wear the uniform," she said. "See you tomorrow."

That night, he called Christa, told her what he was thinking of doing.

"But I'll never see you again!" she said.

"Maybe. You might be surprised; I'm still young." Well, sort of. When he was a kid, his great aunt liked to describe herself as young. Which she was, compared to the hundred-and-two she ultimately reached. "Besides, how often do we actually see each other? We'll still have phone and internet."

"Maybe."

"True. But you don't want your dad to be Machiavelli." He still wasn't so sure about Sun Tzu; there didn't seem to be a lot of actual history about him, and Zeke didn't know how much to believe, anyway. History that old tended to be a bit scrambled.

"Huh?"

"Sorry." She didn't have the security clearance for him to explain. "Let's just say there are certain . . . countermeasures . . . I'm not fond of."

When he really was young, Zeke hadn't signed onto the wormhole project to be a soldier. He'd not signed on to justify the means by the ends. He'd served his time as a strategist, and it was time to return to his roots.

"I need to go out there," he said the next day, waiting for his smoked salmon and Gruyere onion soup in an Annapolis restaurant.

"I thought it might be something like that. Why you?"

"Because this is getting out of hand. And if *we* can think of space mines and barrages of wormhole pairs, so can they. Last night, I did a quick read of Sun Tzu's *Art of War*—it's not really all that long—and one of the other things he said is that you can't win a protracted war."

The soup came, and he paused until the waiter had departed.

"We're the Johnny-come-lately to this game, and whatever we throw at them, they can probably throw worse at us. We're continually escalating a war we can't win."

"That's not what I asked," Radić said. "My question was, 'Why you?'"

"Because I started it."

"That's not quite true."

"Close enough. I've been involved every step of the way." He remembered Trina's illness. "Well, most of them. The point is that if we can establish communication—"

"Big if."

"Yes. But that's the case no matter who goes. I'll want a good link home, but also good onsite computer support in case I lose that link—which, I realize, is the most likely outcome. But *if* I can establish communication, I'm the one who can best apologize. If apologies aren't relevant to the way they think, we're screwed, regardless. If they are, I have the virtue of sincerity."

"You might not be the only one. Remember, when we first met, I told you we had a tiger by the tail. I've spent a lot of nights trying to figure out how we could have avoided that."

Briefly, their gazes met. *Damn this war.* True, nobody could replace Trina. But maybe nobody actually had to. Maybe normal life just lurched in a drunken walk from *now* to *what-comes-next*.

Which, of course, was how Earth had wound up with this particular tiger by the tail and why now, *next* was Zeke traveling to the stars. Alone.

"No," he said. "If this doesn't work, you're needed here. Dubois is smart, but not strategically. Many of the others are there mostly to keep our allies in the loop. You're a lot more important than me." He picked at his salmon. The restaurant had a four-star reputation, but it might as well have been a drive-through. "If this doesn't work, make sure someone takes care of Christa."

"I will." For a second time, their eyes met, and now he was sure of the future that could never have been. "I promise."

Not that it was that simple. What Zeke wanted was a fully equipped spaceship with enough supplies for the rest of his natural life, in case he wound up on his own, cut off from the rest of humanity.

"A really good entertainment library would also be nice," he added. And maybe a dynamite liquor cabinet in case it got too dull. But no, that was the future he'd decided against the day he'd met Livingston.

He also needed a beacon strong enough for the nearest alien wormhole to detect it and maybe, maybe, maybe send someone (or something) to investigate. And, of course, he needed to start out well within Earth's current defense perimeter, so his communication link (and ride home, if he were so lucky as to need it) didn't implode before the Gaians even knew he was there. Not to mention that his wormhole had to be sent off at slow enough speed that it could be halted at the desired location, so it wouldn't fly away at nearly the speed of light.

"Luckily we do not have to make it come to a complete stop," Dubois told him, once Radić's superiors had green-lighted the project. "Just slow it down enough that we can create an electrostatic back-reaction that drops it to roughly your speed without putting too big a jerk on your spaceship. Not to mention that we've got momentum-dampers from the days when we'd hoped to explore Gaia 205c. Nobody wants to step onto an alien planet like they've been dropped off a sky-scraper, do they?"

"As long as it works."

Dubois was as good as Radić at the wry smile. "Well, this will be a good test. But even if it isn't perfect, we should be able to bring the wormhole back to you fairly quickly. We've been doing that kind of maneuvering for years."

"Are you sure you want to do this?" Radić asked one more time, after the plan had gone up through the ranks and across the services. "There are plenty of younger people who'd volunteer."

"Yes." Let the younger ones live normal lives if he succeeded . . . or whatever they might have left of them if he didn't.

Two year later, Zeke was surrounded by stars, his spaceship floating close (but not too close, in case of explosion) to the wormhole he'd come to think of as his own: his data-tether to Earth's supercomputers, his umbilical cord to Christa, Radić, Dubois.

On winter nights at Big Bear, he'd sometimes ventured to trailheads remote from city lights, from which he'd skied, hiked, or snowshoed into meadows of glistening white above which the stars shone diamond hard, bright

and distant. Once, he'd bought a thick, insulated sleeping pad and the warmest sleeping bag he could find and snowshoed far enough into the meadows that when he lay on his back there was nothing but snow, stars, and the delicious combination of a rapidly warming sleeping bag and cold air on his face. So what if he couldn't go south and see the constellation Apus? All that really mattered had been there in that glistening blackness.

Then he'd lost the AE-1, and ultimately, every other wormhole he'd ever commanded.

Now, he was again surrounded by stars—brighter, harsher, more numerous than anything he'd ever seen at Big Bear. Sometimes, he donned a spacesuit, tethering himself to his ship and drifting in the black. From there, he could easily see Apus, but instead of the wonder he'd found in the meadow above Big Bear, what he most often felt was the unseen presence of a thousand swords of Damocles, all suspended over his gently floating body.

The hardest part of launching him into the interstellar dark turned out to be figuring out where, exactly, to send him. Too far out and the aliens would overwhelm his position before they knew he was there, destroying his link home and condemning him to spending the rest of his life in interstellar space. Too close in and he might die of old age before they got to him—especially if the latest countermeasures proved effective. And nobody wanted to relax Earth's defenses just to give him and the aliens a quicker chance to meet.

All of which meant he'd geared up for a long wait . . . assuming the aliens even noticed his beacon. Or cared to check it out. For all anyone knew, they were hell-bent on destroying Earth as quickly as possible. "I think half the joint chiefs think that's what they'd do if they were the aliens," Radić told him in a private communiqué. "The rest think you're our last hope."

And maybe, if you live under the Sword of Damocles long enough, there comes a time when you hope it will drop simply to end the uncertainty.

Time passed. Zeke let his spaceship drift. An old Mars shuttle, it was more cramped than he'd have liked, but there was enough room for one aging man who'd never again

winter camp above Big Bear but who dreamed of a future in which high schoolers ran with no concern more pressing than catching the runner in front of them. In which parents chose to have kids who might have a chance of becoming high schoolers.

And then, amazingly, it happened. A shimmer of high-energy radiation appeared at nearly the maximum distance his instruments could detect, closing at nearly the speed of light, indeed coming from Apus.

Two million kilometers away, the wormhole braked in a shower of Cherenkov radiation that set off alarms all over Zeke's ship. It drew to a halt, still a mere pinpoint in his best telescope. Then it dilated. And dilated. Until an enormous . . . thing . . . emerged. A giant flying block of material that, as best he could resolve it through the scope, looked like a collection of giant beehives. Portals gaped from some of the hives (weapons?) while the entire construct was circled by shimmering light that might be a force field designed to keep atmosphere from escaping.

It wasn't anything anyone on Earth would ever have envisioned as a spaceship. What it looked like was a spaceship from a civilization so dependent on wormholes it never actually had to launch anything the old-fashioned way. It might even be an entire city: a city-space-ship. Far beyond anything Earth could match.

His com exploded in a babble of voices. Then Radić's cut through. Whenever he called home, she was always there. As far as he could tell, she must have synched her sleep cycle to his. Either that, or she slept with her com. "The command-center tacticians say that you've already gotten critical information," she said. Her tone was neutral. "They say that from the amount of mass the aliens appear to have sent through and the range at which they stopped their wormhole, we've learned a lot about their capabilities."

Another voice interjected. "What she means," Dubois said, "is that we can use the braking radiation to calculate the energy at which their wormhole was launched. It will take a while to get good data, but they are clearly orders of magnitude beyond us."

"But that's not the most important thing," Radić said. "The fleet tacticians tell me that the fact that they stopped their wormhole that

close to you means they're confident they can move in a backup wormhole to retrieve their ship within seconds, if needed. If they really can react that quickly, it explains why nothing we've done can stop their advance."

"Which means what?"

"That you were right. This is our only true hope."

The shimmering field surrounding the alien space . . . block? . . . ship? . . . thing? . . . changed colors. Black. White. Red. Blue. Something invisible to his eyes that the telescope registered as near-infrared. Something equally invisible in the ultraviolet. Green. Yellow.

Zeke had no idea what it meant. *Surrender now? Greetings Earthlings! Prepare to be exterminated?* With a thousand swords of Damocles and time bombs flying each way, it could be any of these, or more.

Radić's voice was soft in his ear. "Wow. I've got some old SETI folks online, and they're baffled." She paused, almost chuckled. "Actually, the exact quote is, 'Uh, never thought of anything like that.'" She paused again. "Officially, I'm told to remind you that you have no *official* authority to speak for Earth. Unofficially . . . hell yes you do. If they have the

power to launch something like that, we'll do everything we can to back you up. What are the politicians going to do, fire us?" This time the chuckle lacked any trace of humor. "If they had better ideas, they'd have fired us long ago."

There was click as her voice shifted channels. Less public, though undoubtedly everything was being recorded. "Good luck. By the way, I got them to up Christa's security clearance and she's on the feed, too. She's not allowed to speak, but you know what she'd say."

"Thanks. Tell her . . . Tell her she'd know what I'd say, too."

With an effort, he shifted his focus back to the alien ship. He blinked his own ship's running lights, plus his radio beacon and all other communication frequencies. An acknowledgement or a challenge? Time would tell. Then he eased his ship into motion, even though even at maximum thruster power it would take his puny vessel weeks to cross the distance to the others'.

For decades, he and the aliens had been fighting each other as unseen menaces. No more. Whoever they were, whatever they wanted, it was time to meet them in a much more old-fashioned way. ■

Really Big Tourism

Michael Carroll

The outer Solar System is dark and bitterly cold. Distances make communication and travel daunting. But the outer worlds, giants of ice and gas, possess entourages of moons replete with water, minerals, and hydrocarbons, and it is these worlds that may play a part in humankind's future. Aside from practical scientific and technological gain, travel to the icy cliffs, thundering geysers, incandescent volcanoes, and swirling storms there will bring inspiration. Henry David Thoreau advised us that: "We need the tonic of wildness . . . At the same time that we are earnest to explore and learn all things, we require that all things be mysterious and unexplorable, that land and sea be indefinitely wild, unsurveyed and unfathomed by us . . ." While we've plastered our Earth maps to their corners with satellite and ground surveys, our maps of the worlds beyond still have vast territories labeled *Thar be dragons*. The cosmos compels us to fill them in. We have gone there with our robots, but the history of space exploration shows us that where our robots go, the footprints of humans will follow. And our own planet's history shows us that where explorers go, the tourists will follow.

What will entice the first travelers to venture out among the giants? Exploration has historically been driven by science, economics, and geopolitical forces. The Apollo program, for example, was largely a geopolitical venture, although it paid off in technology, jobs, and scientific knowledge. Over a century before, explorers Lewis and Clark surveyed the western United States at the bidding—and funding—of the United States Government. The opportunities the Pacific Northwest could provide were not yet apparent to the European settlers in the East. But a profit was there for the making, and there were practical and viable ways of carrying out travel and trade. Once the Corps of Discovery had surveyed the Pacific Northwest, the transcontinental fur trade began. At a certain point, when infrastructure had been set down, settlement began in earnest.

This incremental expansion will also occur on the scale of our Solar System, as a natural outgrowth of our first steps, already taken. Several space-faring nations are actively discussing a return of humans to the Moon, and Mars is on the agendas of many, from entrepreneurs to engineers. As humankind eventually traverses the Earth/Mars void,

technologies will advance, making the crossings easier and more cost-efficient. Mars exploration advocate Robert Zubrin says that we need look only to history for evidence of what is to come. "Columbus crossed the Atlantic in very primitive ships, but fifty years later there were caravels, and then there were clipper ships, and then steam ships and Boeing 747s. The grandchildren of the first Mars colonists will hardly believe the stories of what the immigrant experience was like in the early days. The same capabilities that make going to Mars easy will make going to the outer Solar System possible."

But First . . .

Just getting out there is currently an engineering nightmare, and other hurdles face long-distance space voyagers. To the early-twenty-first-century mind, the advances of the next few decades will be akin to science fiction. Laboratories across the world are carrying out research in advanced propulsion ("Ahead, warp factor one."), human hibernation ("Get your paws off me, you damned dirty ape!"), food production in microgravity ("You are *not* using those things in my forest."), and human/technological interaction on extended voyages ("I'm sorry, Dave; I'm afraid I can't do that."). Research continues to advance on many fronts.

Perhaps the biggest breakthrough we'll need is speed. The most formidable aspect of human exploration of the outer Solar System is, very simply, the distance involved. Our closest target, Jupiter, is 356 million miles/588 million km at its closest pass, but we cannot travel so short a distance directly. Traveling to another world is a game of cat and mouse, with an Earthship coasting along an arc stretching across the Solar System to a point in front of the target planet. In effect, the spacecraft must place itself in a position for the planet to catch up to it. Crossing millions of miles of the void involves great spans of time, and for human crews, those spans translate into long-term radiation exposure, subjection to extended microgravity environments, and the consuming of vast quantities of supplies. One solution is to trim down the travel time with powerful propulsion. Thermal nuclear rockets, solar sails, and various types of ion propulsion are all under study. One of the

most promising of these is called the VASIMR engine, designed by former shuttle astronaut Franklin Chang Diaz. The Variable Specific Impulse Magnetoplasma Rocket is an electric engine that uses microwaves to heat propellant, turning it into plasma.

VASIMR shares some similarities with other electric propulsion engines, like the electric propulsion *Dawn* and *Deep Space 1*. The power of a typical ion engine is very low, on the order of a kilowatt (equivalent to the push of a hair dryer).

VASIMR is able to process far more power. The VASIMR engine's power clocks in at about two hundred kilowatts, similar to the power of an SUV. "Now you're talking some transportation," says Chang Diaz. "Now you're talking something more serious, more to the tune of something that can carry a fairly big payload in space." VASIMR could shave a six-month trip to Mars down to a matter of weeks and substantially shorten more distant voyages as well.

VASIMR protects its hardware by using a magnetic field to isolate the flow of the hot plasma. Its magnetic field "insulator" serves as a liner, enabling VASIMR to bring its plasma to millions of degrees, increasing its power.

The problem with a two-hundred-kW engine is that it requires a two-hundred-kW power supply. "You have to have a solar panel that's a lot more advanced, a lot bigger, a lot more powerful," Chang Diaz says. The solar panels on the International Space Station are each capable of producing roughly one hundred kW. Nuclear power is another possibility, but advances will need to be made on multiple technologies for engines like VASIMR to come on line.

Once en route, crews will face other hazards. One of the greatest is radiation. Solar radiation can be deadly, but it can be cut down by a storm shelter—a chamber surrounded by water or hydrogen fuel where the crew can take refuge during deadly solar events. These events would last for only a few hours. However, the constant rain of high-energy cosmic rays penetrates just about anything, and it is relentless. Our planet is shielded from these lethal particles by our magnetosphere, the planet-cooing envelope of fields that deflects particles from both the Sun and deep space. Studies are being conducted to generate

protective magnetic fields around ships themselves. A European team recently estimated that a spacecraft could be shielded within a magnetic bubble roughly one hundred to two hundred meters across, using a system that could be readily carried into space.

Destinations of the Rich and Famous

Once our technology meets our human needs for protection, safety, and health, where will we go? The giant planets themselves are worlds of hydrogen weather. Any solid surface exists far below the cloud tops where humans might survive. If people wanted to visit the gas and ice giants, their most likely form of outpost would be a buoyant station; a city in the sky.

The NASA Glenn Research Center has actually done a study of such a facility for Venus. Geoffrey Landis headed up the study. The floating outpost would cruise at an altitude where air pressure is equivalent to that at Earth's sea level, and the heat drops to room temperature, a comparatively benign environment. Landis' report concludes, "In the long term, permanent settlements could be made in the form of cities designed to float at about a fifty-kilometer altitude in the atmosphere of Venus."

But what of cloud cities on the outer planets? The atmospheres of Jupiter, Saturn, Uranus, and Neptune are dominated by hydrogen and helium, the two lightest gases around. This makes "lighter-than-air" balloons impossible, but Landis says there is a solution. "It's been proposed to float hot-hydrogen balloons—as long as you heat up the gas inside the envelope to hotter than the ambient, it will float."

The fierce radiation environment surrounding Jupiter may not be an issue. Jupiter's radiation drops to low intensity at the level of the Jovian cloud layers, and temperatures are fairly benign as well. Wind shears are terrific, but within a belt or zone, riding the currents, the breezes may be fairly stable. Perhaps the main problem of living in a cloud city on the giant planets is that your home would be permanent: There doesn't seem to be a practical way to return to Earth from Jupiter's immense gravity well. The other three worlds are a different story. Saturn is an especially easy planet from which to depart. Its surface gravity is about

the same as the Earth, but it also has a very high rotational velocity, so that an atmospheric craft could actually reach orbit within known engineering concepts.

Fortunately for future explorers, the giant planets are surrounded by a host of natural sites ripe for the settling. The ice and rock moons of the outer Solar System range from mountain-sized boulders to planet-sized behemoths. One early strategy of outer planet exploration may be to establish a beachhead on the smallest moons. These mini worlds have the advantage of proximity to the giant planets and their large satellites, while having the low gravity from which to come and go. At Jupiter, in particular, the small moons Elara, Himalia, and Leda orbit outside of the deadly radiation belts, but near enough to operate telerobotics on the major Galilean satellites. Saturn's moons Pandora, Prometheus, Janus, and Epimetheus would provide close bases from which to research the major moons, but they would also afford spectacular edge-on studies of the ring system and its complex wave dynamics. The smallest moons of Uranus would offer no real advantage, as the mid-sized Uranian satellites (Miranda, Ariel, Umbriel, Titania, and Oberon) have low gravity anyway. At Neptune, some of the smaller moons might be tempting targets, simply because Triton is a difficult place to land. Triton orbits in a retrograde direction, opposite to the natural orbital motion of moons in the system or approaching spacecraft. Because of this, Triton's landing speeds are high. Its gravity is also substantial. Among these targets will be Proteus, Larissa, Galatea, and Despina. At a distance of up to ten million kilometers, Nereid's oddball orbit may range too far away from the Neptune system to make it a practical observation or telerobotic site.

The view of Jupiter from its four largest moons, the Galilean satellites, will be spectacular. Unfortunately for the closest of them, it will also be deadly. Jupiter's radiation bathes volcanic Io and icy Europa in waves of lethal radiation from its strong magnetosphere. On Io, explorers would receive a fatal dose of radiation in minutes. Still, there may be locations suitable for human visits, if not habitation. World-renowned Io expert Rosaly Lopes of NASA's JPL points to underground

lava tubes, caves that would provide protection from Jupiter's blazing radiation. "We expect that there would be lava tubes because of the type of lava flows we see. I think they are pahoehoe flows similar to Hawaii. However, it's a really different place in which to set up anything. You would have to keep people underground and then you would build your modules with pressure, food, etc." But due to Io's frenetic activity, underground outposts are a risky proposition. Researchers believe volcanoes on Io are active for decades. Lopes warns, "You would have to be very sure that you're not going to get another volcanic eruption filling in those lava tubes, and how are you going to predict that? Even if there was an empty tube, are you going to go to all the trouble and expense to set up something now when there might be lava coming down the tube in the future?"

More benign counterparts of Io's lava tubes will likely be found on the ice moons that have been cryovolcanically active. Worlds like Ganymede, Enceladus, Miranda, and Ariel may well have flows of ice that have drained, leaving sheltered underground chambers just waiting for future settlers. These naturally pre fabricated icehouses will be more stable in the geologically quiet environments that remain today.

Less challenging from a radiation standpoint than Io is the next moon out, Europa. While Io circles the king of worlds at a scant 421,700 km from the planet's center, Europa orbits Jupiter at a distance of 676,800 km, nearly twice the distance from the Earth to the Moon. Nevertheless, the little ice satellite is still well within the Jovian magnetosphere. Radiation levels are about 540 REM per day, 40 REM more than a fatal dose. Most of that radiation, carried by Jupiter's magnetosphere, slams into the back of Europa. Erosion and radiation damage can be seen on the trailing hemisphere area, but another radiated band stretches across the equator. What does this mean for travelers? The best places to go for low radiation are at high latitudes, avoiding the trailing hemisphere.

For exploration, Europa has the added attraction of its subsurface ocean. Some sixty miles of briny abyss lie beneath the frozen crust, and scientists would like to see what's down there. Probes with heating elements or drills have been tested in Antarctica's Lake

Vostok and other sites, but getting through the ice while maintaining radio contact is a difficult chore, especially if that ice turns out to be twenty kilometers thick. But eventually, technology will out, and it will be time for humans to go. Perhaps Europa's crust has thinner areas suitable for dropping a submersible through a borehole. Humans may even free dive in pressure suits adapted to the alien environment. Adventurers and researchers will find a similar situation at Saturn's Enceladus, where the subsurface ocean appears to be localized around the south pole. Engineers might erect a pressure dome first, in order to keep any water from boiling violently into the vacuum of space. Then, they would set to work drilling a tunnel through the ice crust. When the time was right, they would lower their spiffy submarine, complete with highly trained crew, into the depths of an alien sea.

Once we have learned to use the resources available among the giants, and once we have developed a network of infrastructure from the terrestrial planets to the outer system, people will begin to travel for reasons beyond science and exploration. They will travel for leisure and entertainment. Engineers and entrepreneurs will establish nodes at the locations best suited for navigation and richest in resources. In the Jovian system, these might be found at Ganymede and Callisto, while at Saturn, Titan's rich environment may be a strategic player. These three candidate moons have surface resources, but they also have a strong enough gravity well to be helpful as a slingshot for travel into and out of their immense planetary systems.

Ganymede and Callisto, the outer of Jupiter's huge Galilean moons, offer icy wonderlands for future adventurers. NASA Ames' Jeff Moore is particularly interested in Callisto as a strategic location for science and tourism. "It's clear that the rocket barons of the twenty-first century think they can make money off space tourism," Moore suggests. "So if space tourism seems to be a possibility, I think it's a no-brainer: you go to Callisto. You'd build a few tourist resorts with a spectacular view of Jupiter, with the Monument Valley-like foreground around you, like visiting Moab. Those scenes would be pretty hard to beat, but you'd also get great views of the other Galilean satellites and Jupiter itself. Callisto is it for the 'wow' factor."

Moore also prefers Callisto's low radiation environment. "It's the only Galilean satellite you can visit and not get properly fried by the radiation. It's such a nasty environment to actually send humans out to Europa, which is certainly one of the most interesting satellites scientifically. Ganymede is not as bad as Europa or Io; you might get by in your lead underwear." Moore envisions inhabited bases on or around Callisto, where researchers tele-operate equipment on the surface of Europa or Io. The time lag would be somewhere between four and eight seconds, depending on where you are in your orbit. "It's enough to be annoying, but it sure beats the heck out of a 45-minute time lag from Earth."

Saturn's giant moon/planet Titan may have the most to offer future settlers and tourists, says Ralph Lorenz of the Johns Hopkins Applied Physics Laboratory. "If you define 'Earth-like' as an environment in which an unprotected human would survive longest, Titan is second only to the Earth. Put an astronaut on the surface of Venus, and it literally cooks them in an instant. On Mars, the low pressure is such that it would suck all the air out of your lungs so that you would pass out within a few seconds. On Titan, you could hold your breath. The atmospheric pressure is just a little bit higher than Earth, so you could probably walk around for a minute until you passed out from lack of oxygen. If you had an oxygen mask—just an oxygen mask without a pressure suit—you'd be fine for rather longer. It's a very cold environment, so you would chill down after some minutes or tens of minutes, but maybe a thick parka or an insulated suit would keep you going for much longer. So you could imagine landing a spacecraft anywhere on Titan and coming out in an environment suit, but the suit need be much less elaborate than anywhere else."

Titan's dense atmosphere and light gravity—a mere 1/10 that of Earth's—will make travel easy. Hot air balloon probes, driven by the waste heat from a radioisotope generator, are currently under study. In Titan's nitrogen air, helium- or hydrogen-filled balloons could support airships. Aircraft and helicopters would work well. Hovercraft have even been speculated. On the seas, engineers imagine floating vehicles and submarines. A host of vehicles make sense at Titan.

Lorenz has a particular affection for the methane seas of Titan. In particular, we know that the largest sea, Kraken Mare, has two large basins that are separated by a fairly narrow strait that Lorenz has nicknamed the "Throat of Kraken." "It's about the same size as the Strait of Gibraltar, about seventeen kilometers across. There is a tide in Titan's seas forced by Titan's eccentric orbit around Saturn, so there should be a tidal current that goes one way through these narrow straits at one part of Titan's orbit and then eight days later it goes the other way, a tidal race. It could be that even when there's no wind, those tidal currents may roughen the sea much as they do in tidal races on Earth (for example, at Skookumchuck Narrows in Canada or the Corryvreckan in Scotland)." Lorenz would be the first to sign up for a speedboat tour of these tidal straits, circling whirlpools and rough sea surfaces where the tidal current swirls past bumps and pinnacles on the sea bed, spewing off vortices and waves in their wake. "You can actually hear this stuff roar. It would be really cool to either stand on the beach or the cliffs at the edge of this tidal race hearing this—you could hear it on Titan because it has an atmosphere that transmits sound very well—hearing the roar and maybe seeing whitecaps on the tidal currents. With a little bit of imagination, and maybe with some polarizing sunglasses to help cut the effect of the haze, at that point on Titan you would be able to see that Saturn was in the sky."

JPL planetary scientist Kevin Baines sees even more potential for Titan as a strategic location for future travelers. He envisions future tourism in the Saturnian system as being much like travel in the Caribbean or the Greek Islands today. "It would be a great tourist destination. It's like going to the Greek islands on a cruise ship. Each Greek isle is unique. It's the same with the moons of Saturn." Baines imagines day-trips from the environs of Titan—perhaps orbiting transit stations—to the yin and yang landscapes of Iapetus, the battered highlands of Mimas or Tethys, and the geysers of Enceladus. "You would have cruise ships docking at different moon ports. Of course you would spend a day just hovering over the rings. You don't want to go through the rings, but because of orbital mechanics the little

ship wants to go through them, so you'd have to keep firing your rockets to stay up."

For future visitors to the giants, cruising the Saturn system will be no more bizarre than the idea of cruising the Caribbean would have seemed to medieval Europe. With some specific technological advancements, it will logically happen.

But there's more to see out there. The diminutive Uranian satellites have some of the most spectacular geology in the Solar System. Mountain climbers will thrill to the sights from Ariel's sheer canyon walls, illuminated by the sapphire glow of Uranus. Above, Uranus would appear as far across as 32 full moons in Earth's sky. Neighboring Miranda has an even more dramatic cliff. Verona Rupes is ten times the depth of North America's Grand Canyon, at roughly twenty km deep. BASE jumping thrill seekers might enjoy the 12-minute freefall to the bottom of the precipice, where they could cushion their landing with a rocket pack or airbags.

Neptune's celebrity moon Triton provides a spectacular view of the cerulean ice giant. Unlike the big moons in the Jupiter or Saturn system, which travel sedately around the equator with an unvarying equatorial view, Triton is blessed with a roller-coaster orbit. Its inclined path takes it high above the north pole, and then brings it swooping down through the equator, under the south pole and back up again. Triton endures this amazing sky show every six days. The view of Neptune changes dramatically as Triton's day progresses. Below that entertaining sky lies one of the most alien landscapes ever witnessed by human eyes. Jumbled cantaloupe terrain gives way to glistening ice plains peppered by impact craters, volcanic calderas, and cryolava flows. Beyond spreads the pink nitrogen polar ices, where Triton's unique geysers rise some eight km overhead. At the horizon, travelers will see

haze layers, but the sky will undoubtedly darken to a deep purple or black overhead in the rarified air.

More Than a Playground

With human exploration of Mars perennially "two decades away," it may seem premature to entertain the possibility of human ventures among the gas and ice giants. But they are important, says Carolyn Porco, head of the Cassini Saturn Orbiter imaging team. "No matter how you measure it, whether you count the number of bodies, whether you add up the amount of mass, or whether you calculate the volume taken up by the orbits of those bodies, the vast majority of our Solar System lies out beyond the orbit of the asteroids. Inside are just bits of flotsam. It's all in the outer Solar System."

If Thoreau was right about our need for the "tonic of wilderness," future travelers will undoubtedly find such an elixir among the giants of the outer worlds. The concept of frontier, of a place for expansion and colonization and conquest, drove early European settlers across the Americas. The western "wilderness" was seen, by many, as a source of natural resources or a playground rather than a place of natural beauty. Some even cultivated an adversarial attitude, seeing humankind's role as forging order out of the natural chaos. But wilderness was also seen as a place of sanctuary, of mental and spiritual renewal, a realm that had aesthetic worth and intrinsic value. As our VASIMR engines and magnetosphere-generating craft bring us to the vacation ports of the outer Solar System, how will we view the new wilderness?

For more on the subject, see Michael Carroll's book, *Living Among the Giants: Exploring and Settling the Outer Solar System* (Springer, Christmas 2014). ■



Illustrated by Karla Castaneda

Very Long Conversations

Gwendolyn Clare

Becca drove the open-topped hovercart across the sea of rust orange grass, lamenting not for the first time her limited anatomy—two eyes, two hands, ten fingers. Never enough of anything. She felt muzzled by her inability to sign and steer at the same time, made worse by the claustrophobic clinging of the biosuit membrane around her face.

Shurza could have driven and conversed at the same time, but he was hunched down in the footwell of the rear seat to avoid the airflow, his fore-eyes and hind-eye squeezed shut, his expressive facial features tucked behind his hands in discomfort. Becca had put in a request for a hardtop for the hovercart, but the planet wasn't open for colonization yet, so it would be weeks before the re-

search station received their next supply drop.

Their destination stood out against the tallgrass savanna like the naked trunk of a dead tree, and as Becca pulled the hovercart to a stop and lowered it gently atop the vegetation, she realized that the mystery object was indeed made of wood. She reached behind her seat and tapped Shurza's back to let him know they were there, then hopped out. He climbed after her, his motions slow and smooth despite the abundance of spindly limbs—not at all the jerky, insect-like movement everyone always expected of Albedans. Watching him, Becca felt one of her brief flashes of cognitive dissonance: awareness of how strange it was that her life with the Albedans no longer seemed strange.

They waded through the stiff, hip-high fronds of grass to a patch that had been pressed flat around the wooden pillar. No, Becca mentally amended as she looked closer, not pillar—statue would be a more accurate descriptor. When Shurza had pointed it out to her this morning, she'd gotten a hollow feeling in her stomach. There was something about living isolated on an uninhabited planet that made any unexplained phenomenon seem sinister.

"It's a stick figure," she muttered aloud, leaning closer to the crude statue. "A figure literally made out of sticks."

Beside her, Shurza pointed a finger at the side of his earless head, then touched the same finger to his facial feelers, using a human sign for *deaf*.

Becca pressed the heels of her palms together and switched to the pidgin sign language that was the best she could manage with only ten fingers. "Sorry. I was just saying it looks like something a human child would draw."

She turned to watch his reply take shape upon the dexterous starburst of his feelers. "So someone's playing a joke on you? Jeph, maybe?"

"I suppose." She glanced back at the field station, the upper levels visible above the expanse of tallgrass, and judged the distance to be maybe three kilometers. "We've got line of sight from the station, and it wasn't here yesterday, so I think the extinct indigenes can be ruled out."

Shurza picked his way carefully forward on his eight pairs of delicate limbs and rested a hand on the lashed-together twigs and branches that composed the statue. It was more than twice his height; he was considered short and stocky for his species, the top of his head only reaching Becca's elbow.

"Two arms, two legs, one head. Definitely supposed to be human," she observed. Shurza was still facing the statue, but his hind-eye watched the motion of her hands. "What is this—braided vines?—holding it together? And the sticks look dry, not fresh-cut."

Shurza used another human sign, this time the loop that meant *crazy*.

Becca couldn't disagree. Collecting the materials must have taken hours, let alone the construction time. "A lot of effort for a joke."

He pulled apart one of the complicated knots with his small, slim hands, scrutinizing it, then retied it and stepped back. "The details are meticulous. Must have been one of the archaeologists," he said, but then he pursed his facial feelers doubtfully.

"Right," she said, holding her own doubts close to her chest.

A breeze picked up, turning the grassland into an expanse of undulating motion, like the hide of some enormous breathing creature. Beside her, Shurza tucked his head down, eyes squinted and feelers stiff. By Albedan standards, Shurza was psychotically unafraid, but the wind must have felt like an assault to someone born on a planetoid with only a trace atmosphere.

Becca inclined her head toward the hovercart idling in a nest of grass. "Let's head back."

They went through separate decontamination airlocks—Becca peeling off the membrane of her biosuit while Shurza scrubbed down in a vacuum chamber—before entering the inner sanctum on the field station.

"You're back!" A tiny marauding blur of legs and feelers barreled down the hallway at them.

"Hi, Kipparou." Becca crouched and the young Albedan leapt onto her knees and balanced there, quivering with excitement. Kipparou had grown too large to ride on Becca's shoulder as she had when still a baby.

"What'dyousee? Didyoufindanythingcool?" Kipparou's feelers moved so fast Becca had trouble parsing the words.

Becca tried to describe the stick figure without hinting at her own uncertainty over its origin, but Kipparou could be annoyingly perceptive.

"You don't *know* it was made by a human. It could have been aliens." She clapped her hands together, delighted. "Aliens!"

Becca suppressed a smile. Kipparou often forgot that, for the rest of the expedition team, the Albedans were the alienest of aliens. "It could have been," Becca admitted before changing the subject. "Did we get a message from your aunts?"

Anchali and Dareem were Becca and Shurza's respective partners. Neither was Kipparou's actual aunt, but the Albedans always adopted genetically unrelated children from neighboring towns, so familial relations were nebulous at best—"aunt" was close enough.

"Yes, but Dareem said their transport's been delayed another month." Her feelers drooped sulkily, then perked up again as her train of thought veered off in another direction. "So when do I get to explore outside?"

"When you're tall enough we won't lose you in the grass," Becca said.

"But I wannago NOW!"

Becca sighed and glanced at Shurza for support, but he just said, "Don't look at me. She gets her impatience from you."

"Well, right now I have a different mission for you," she said to Kipparou. "Could you find Jeph and ask him to meet me on the observation deck?"

Becca sat back in her chair while Jeph held the binoculars to his eyes and leaned close to the glass wall of the observation deck. Without any visual enhancement, the wooden figure looked like nothing more than a dark, vertical smudge to Becca's eyes. A herd of plantigrades grazed a little ways beyond, the gray humps of their backs visible above the grass, their progress seeming as slow as the movement of the sun at this distance.

"So, seriously—it wasn't you?" she said.

"No! How many times do I have to tell you?"

"Hmph. Methinks he doth protest too much."

Jeph pressed a hand to his chest. "Your suspicion wounds me. Also, were I to pull a

prank on you, it'd be something that produced a more spectacular result with less effort."

"Yeah, I kind of thought it wasn't your style." She stretched her arms over her head. "Weird though, isn't it?"

"Agreed."

Becca watched Jeph's profile as he looked through the binoculars. They'd known each other a long time—since before first contact with the Albedans—but the rest of the archaeology team was new to her as of this expedition. It didn't make sense for one of them to pull a prank on her.

Maybe it hadn't been meant for her. Maybe it wasn't a prank at all. *Maybe its builder wasn't human.*

But there was no sign of whatever sentient species used to reside on this world, no extant sign at least. If the indigenes were still alive, Becca wouldn't be the only exobiologist in a team of archaeologists.

A movement off to the left caught Becca's attention. "Hey, gimme the bins."

A lone plantigrade had wandered near the station. Usually the fauna gave the unfamiliar structure a wide berth, but not this one. Becca held up the binoculars for a better look.

The plantigrade was about the size of a rhinoceros, though less heavysset and wielding a short, dexterous proboscis. Both the males and females had wide, flat tusks angled low over the ground—used more often as scythes to cut through stiff grass stalks rather than for rooting in the earth—so Becca couldn't judge the gender from a distance. This plantigrade had a very long tail with a particularly bushy tuft at the end, which Becca believed was an indication of advanced age.

She sighed. "I wish I was here to study the fauna. Not that I mind working as a translator, but . . ."

Jeph gave her an exasperated look. "Becks, the last official job you had as an exobiologist, you ended up coparenting an alien baby. You seriously fail at the noninterference principle."

"The Albedans are sentient. They're not study subjects." She raised her eyebrows at him. "And I'd think an exolinguist should try to be a little less of a speciesist."

"Mostly, this exolinguist is just impressed you didn't trip over the word 'speciesist.'"

"Whatever," she said. "I thought you, of all people, would be more supportive."

After her first engagement went up in smoke, Becca had accepted that being alone was the price she paid for a career doing interstellar fieldwork. She'd never expected to end up with a complicated interspecies family, and the doubt still gnawed at her. Was she doing the right thing, raising Kipparou with so much exposure to human culture? And was it right for human-Albedan relations, or right for Kipparou herself?

Jeph shrugged off her criticism. "I'll take a closer look later, if you want, and ask the archaeologists about it."

"Thanks," Becca said. She took another look through the binoculars. Though the stick figure had no face, she imagined it was staring straight at her.

According to Jeph, the archaeologists apparently decided that the statue was an elaborate hoax aimed at them and perpetrated by Becca herself. With no one willing to confess, they all had to give up hope of an immediate resolution and go back to business as usual.

As a member of the only other sentient species in known space, Shurza was on the expedition team to provide another perspective on the indigenes. So the next day, Becca, Shurza, and Jeph went out to a field site with one of the archaeologists. Temperance was short and compact, well-muscled, with hair trimmed close to her scalp—attractive, but not really Becca's type. So far, all Becca knew about her was that she was a competent driver and not much for small-talk. And she'd either volunteered to take Shurza around to the sites, or she'd drawn the short straw.

Temperance parked the hovercart on a sandy floodplain a ways from the site, and from there, they proceeded on foot through a sharp narrowing of the valley. Becca felt superhuman in gravity lighter than Earth-normal, though she worried about Shurza walking so far. This planet weighed him down like he was dragging stones. The vegetation, at least, wasn't much of a hindrance—the plantigrades had stomped trails all up and down the valley. The river must be an important source of drinking water for the local herd.

Farther upstream, they came upon an exposed cliff-face composed of limestone, the

soft rock hollowed out by rain or floodwater beneath an overhang of harder stone. The gently curved back wall of the hollow was covered in abstract carvings that stretched away up the valley, obscured by the riparian scrub. At regular intervals, the carvings were accompanied by sculptures made of carefully piled stones, some of which had collapsed under the weight of time.

Jeph whistled. "How far does it go on for?"

"The entire length of the exposed rock formation," said Temperance. "Half a kilometer or so. A few sections are badly eroded, but for the most part it's in good condition considering its age."

"How old?" he asked.

"Hard to say exactly. Isotopic dating's useless, since it would only tell us the age of the parent rock, not the age of the carvings. From the weathering, I'd guess at least a millennium. We've collected some floodwater deposits, which should give us a hard upper limit on how recent it is."

Becca, for her part, stayed quiet and translated their conversation. Shurza watched her hands with his hind-eye while tracing a finger along the deep lines of the carving. He turned to face her and said, "The details are quite intricate."

Jeph nodded at Becca's translation and asked Temperance, "Still haven't found any tools?"

"Well, that's the odd part," she said. "We actually have found some crude stone tools, but they're carving tools. No spearheads, no needles, no scrapers for preparing animal hides—just the tools needed to craft the artwork. The indigenes worked clay and wove grass, but again: we can only find the art. No practical applications like pottery or baskets."

Shurza studied Temperance with that steady stare of his, the one Becca knew unnerved other humans. "Your prehistoric tools were mostly implements of death," he said. "Maybe the indigenes were herbivores."

"Still, you'd expect vessels for carrying water, or maybe grinding stones for grain," Temperance said, addressing her answer to Becca instead of Shurza, as if the translated thoughts belonged to the translator.

Jeph was tilting his head to the side and frowning. "And wouldn't you expect some of this to look like something? Early human art

was representational. Ditto with written language—all the early writing systems were logographic.”

“There are some repeated images, like this one.” Temperance pointed to a carving that looked like an asterisk. “But it’s impossible to guess the correct interpretation. It could be a sun, a flower, an explosion . . .”

“An Albedan’s facial feelers,” Becca interjected.

“ . . . or it could have no meaning at all,” Temperance finished. “Just something they found aesthetically pleasing.”

Jeph wandered upstream a ways to crouch beside another rock pile. He examined the rocks, looked up at the nearest carvings, then moved on to a third pile and repeated his examination. “Hey Becks,” he called. “You got a column of three rocks over there?”

Becca translated the question so Shurza would know what she was doing before she leaned closer to the nearest rockpile, hands on knees. At first she’d thought it was just a messy sort of pyramid, but upon closer inspection, she could see more complex structural elements, some of which stood alone while others supported the greater whole. Tucked away behind a curved, ascending wall was a short column only three stones high.

“Yeah, found it,” she shouted.

Jeph jogged back to rejoin the rest of the group and bent to get a better look at the short rock column Becca had found. He pointed to the rocks in order from top to bottom. “Big and flat, little round, medium round,” he said before turning around to face the carvings. “Sun above squiggle. You see? There aren’t just repeated images, but repeated motifs.”

“In other words, syntax,” Becca said. “That’s what you’re thinking.”

Jeph grinned his usual lopsided grin. “Now you’re seeing things like a linguist. There may be hope for you yet, Becks.”

She gave him a halfhearted punch to the shoulder. “Remind me: which of us is the alien translator here?”

Jeph harrumphed. Despite more effort than he’d admit to anyone else, his Albedan sign language was still pretty abysmal. Becca tried not to tease him too much about it.

She explained Jeph’s theory to Shurza and then asked, “What do you think?”

Shurza wriggled his feelers thoughtfully. He walked a slow circle around the arrangement of rocks, examining it from multiple angles. By the time he was ready with an answer, Jeph and Temperance were deep in a discussion about pattern recognition software, but Becca ignored them and waited.

“If this is a writing system, what do the stones signify? And why can’t it be expressed in two dimensions, carved into a limestone wall like the rest of these signifiers? I think,” Shurza said, “we won’t understand the indigenes until we understand this pile of rocks.”

Becca stood outside the door of the sun deck, pausing to watch through the tinted glass. Shurza and Kipparou sat inside, bathing in natural sunlight supplemented with short-wave-length radiators. Their sunsails, fully extended, glittered in the morning sun like golden dragonfly wings. They looked so calm, so at peace with the world—phototrophing was practically the only activity Kipparou would sit still for.

Becca should be used to the routine by now. While the Albedans sunned, she ate breakfast with the rest of the humans, getting her morning nourishment over with as quickly as possible. Shurza had come to terms with the idea that humans ate other living organisms, at least conceptually, but she knew he still found the whole process of mastication unsavory on a visceral level.

When it came to Albedan mealtimes, Becca was the one stuck on the outside. Not that the door was locked or anything—and some part of her was tempted to throw caution to the wind and let herself in—but she’d already exceeded her recommended annual limit of radiation exposure. And if she let herself do it once, the second time would be so much easier, and the third would hardly seem to matter at all. She doubted Shurza would kick her off the sun deck, either—she’d explained that humans were radiation-sensitive, but it still wasn’t intuitive to an Albedan to worry about exposure. Shortwave radiation was a fact of life for them, and air a precious commodity. Away from their home world, it was easier to forget such fundamental differences.

No, Becca thought, hardening her resolve to stay on the safe side of the door. And then, sadly, *I will never share a meal with my own daughter.*

She was about to go when Shurza opened his hind-eye and noticed her. He tucked his sunsails against his back and stood with his usual liquid grace, then slipped through the door.

"I didn't mean to disturb you," Becca said.

He twitched a feeler at her. "You couldn't if you tried." A human might have asked why she had interrupted, or what she wanted, but he just blinked at her and waited, trusting that an explanation would come in due time.

"If you're done, there's something you need to see."

"It appeared overnight," Becca said.

The new figure stood beside the first one, bundles of sticks held together with meticulously knotted vines. It was shorter, with a horizontal abdomen and an abundance of thin legs. An Albedan stick figure.

The trampled patch of grass was larger now, to accommodate both statues. It reminded Becca of a crop circle, but it would take too long to explain why that was funny, so she kept her amusement to herself.

Shurza walked a slow circle around both figures, taking his time to examine them. "Did you check the station logs?"

Becca nodded. "Unless one of the archaeologists is also a hacker with a bad sense of humor, everyone was inside all night."

Shurza settled on the matted-down grass, opened his sunsails, and stared up at the statues thoughtfully. After a moment, Becca joined him on the ground, sitting cross-legged at an angle to him so she could still see his feelers.

Eventually, he said, "I believe it's time we reconsider our assumption that the indigenes are extinct."

"Agreed," said Becca. She'd already arrived at that conclusion, but she'd wanted to see if he would, too, independent of her opinions. "So we're looking at a first contact attempt, here. This is a sort of three-dimensional written message."

"No . . ." Shurza said. "The message is 'hello.' All of this"—he gestured to encompass the statues—"is just the address the message is being sent to."

Becca nodded slowly. "Which explains why they needed to add an Albedan statue: to extend the greeting. They must not have seen you before our trip out to the valley."

"They were watching us," he said.

The biosuit membrane wicked the moisture off her suddenly sweaty palms, leaving her hands with a tingly cold feeling. "We're on white sands," she said, an old Albedan idiom.

He gave her a considering look. "You've walked stranger territory than this."

A lone staggerbat swooped out of the sky and latched onto the human figure's head with the hooked thumbs of all four wings. It turned a baleful glare upon Shurza and Becca and squacked loudly, as if it found their presence especially rude.

Shurza blinked at the staggerbat curiously. The aggressive posturing of a smaller species toward a potential predator was lost on him. Albedans had no evolutionary programming for fearing other organisms—they were afraid of suffocation, blindness, injury, and getting lost, but predator-prey relations were a mystery to them. Still, the staggerbat had a point.

"Our little friend here is right," Becca said. "This isn't our world. We can't open the planet for colonization if it's still occupied."

Shurza took so long to reply, she was starting to wonder if he'd seen her words. But no, he was just thinking and finally replied, "We need proof."

Becca found Jeph in the conference room, monopolizing the wall-mounted touchscreens. He was sorting through images of the rock piles—comparing, zooming in, rearranging, and finally isolating smaller parts of the whole.

"I thought you'd be running analyses by now," said Becca.

He looked at her for only a second before turning back to the screens. "Turns out, linguistics software isn't equipped to identify morphemes from a video of a pile of rocks. So I'm stuck looking for meaningful consistencies the old-fashioned way."

Becca pulled a chair away from the conference table, straddled it, and rested her forearms on the back. "I want you to entertain a hypothetical for me: What if the indigenes aren't extinct?"

"Hrm." He paused what he was doing. "Speaking very hypothetically, if they're an extant species, they'd probably have to be actively avoiding us."

"I was thinking their population might have a low carrying capacity, like an apex predator, so there just aren't very many of them. It would also explain why they don't make hunting tools, if nature equipped them just fine in that department."

"Yeah, but it would sort of un-explain why they needed to evolve language. Communication is only a necessity for highly social species, like apes trying to avoid getting eaten by the apex predators."

Becca nodded, conceding the point. "My other thought was a strictly nocturnal lifestyle."

"Or they're invisible," Jeph said. Becca raised an eyebrow at him, but he just shrugged. "Hey, you wanted 'hypothetical'."

"So helpful," she said dryly. "If you try to propose they're hyperintelligent globs of primordial goo, I'll throw something at you."

"Well, I was going to say—" he began, but then his eyes focused behind her and he said, "Hey, Tem. What's up?"

Becca looked over her shoulder. Temperance was clutching at the door handle as if it might try to escape her grasp, her eyes wide with excitement. "Guys, we struck gold with the spectral analysis. You have got to see this new site—I'm heading out there now. Come on!"

The new site was even farther up the narrow part of valley, so the fastest access route involved landing the hovercart above the steep valley wall and climbing down. Here at last was a situation where Shurza excelled, scrabbling down the cliffside well ahead of the humans. Becca could tell he was placing his toes carefully, on account of the gravity and his fragile skeleton, but he was still better adapted for the near-vertical terrain than any biped could be. His surefootedness could put an alpine ibex to shame. The humans, on the other hand, had to don climbing harnesses and rappel most of the way down.

At the bottom of the cliff-face, there was an enormous curtain of vines supported by a latticework of old branches lashed together in the now-familiar indigene fashion. One section had been pulled back to reveal the mouth of a broad, gently curving tunnel. Temperance led the way, anxious to catch up with the other archaeologists. Becca walked slower, taking it all in.

On the right, the outer wall was rough stone, while the convex wall on the left was

entirely composed of clean white bones, tied together and mounted within a web of vinework. The archaeologists had set up electric lanterns at intervals along the tunnel, though as Becca's eyes adjusted, she also noticed the dimly bioluminescent microbial mat coating the ceiling.

"It spirals in on itself," said Temperance. "This is the oldest section of the bone sculpture. It looks newer toward the center. And get this: there's a pile of tools and construction materials there, as if they're still working on it." Her eyes seemed to flash with excitement in the light of the closest lantern.

Becca traced the line of a tusk bone with one finger. Somehow, the skull was angled just right to evoke a sense of motion, as if it were about to step out of the bone wall and lift its nose to sniff her.

"Come on," Temperance urged. She rushed forward, disappearing around the bend of the spiral.

"Wait, Jeph," Becca said, grabbing his arm. "These aren't just any old bones, they're all—every single one of them—plantigrade bones." She took a deep breath and let it out. "This isn't a sculpture. . . . It's a memorial."

Jeph frowned. "Why would the indigenes build a memorial to some other species but *not* memorialize their own dead?"

Becca cast him a significant look. "They wouldn't."

"You mean . . ."

"I think the plantigrades *are* the indigenes." Becca quickly translated the conversation to solicit Shurza's thoughts.

He pursed his feelers thoughtfully. "This is more than a memorial. It's a collaborative historical document, each generation adding new chapters, new complexity."

Jeph nodded. "Sculptural writing, not sculptural art."

"No, this isn't a representation of language," Shurza said. "This is the language itself—the only means they have for communicating complex ideas. A sign language made, not with hands or feelers, but with objects. Rocks, sticks, vines, even carved into the landscape."

Becca said, "Each site is a conversation, spanning years or even generations. They literally speak through their art."

Jeph whistled through his teeth. "How do you learn from a kilometer-long philosophical

argument? Their brains must be . . . I can't even begin to guess how they think."

"They haven't been avoiding us, this is just the way they talk." She laughed. "They *never* communicate face to face—they probably have no conceptual understanding of why anyone would want to speak directly."

Shurza ran his fingers lightly over a section of the bone sculpture. His feelers held still, and he had an air of resolve about him. Becca had seen that look before.

She narrowed her eyes at him. "What are you going to do?"

"Come back out in the morning and start gathering sticks," he said.

"You want to build a giant stick-figure plantigrade?"

Shurza lifted his palms in an Albedan approximation of a shrug. "It would be rude not to reply, don't you think?"

"A simple greeting would take hours. Constructing any kind of meaningful communication might take months or years," Becca protested, but in the back of her mind, she was already considering which plants would yield the best materials.

Shurza flicked a feeler at her, teasing. "I suppose it's a good thing, then, that one of us is patient."

Kipparou perched on the padded arm of Becca's lounge chair, a tiny set of binoculars pressed to her fore-eyes. Through her own pair, Becca watched Jeph arranging a pile of sticks into the likeness of a plantigrade limb. Shurza, in charge of the project, was taking his time with the vine-rope knots. Temperance gestured wildly, trying to communicate and probably getting impatient with Shurza's slow, meticulous approach. Becca smiled.

A gentle tap on her forearm told her that Kipparou wanted to talk, so she set down her binoculars. In Albedan fashion, she held still and waited for Kipparou to gather her thoughts.

"Why are you in here, instead of outside helping Shurza? It's not that you want him to

fail—you're excited about speaking with the plantigrades," she observed.

Becca said, "It's complicated."

Kipparou settled down and stared at her, awaiting the complicated explanation.

Becca sighed and relented. "Do you remember when you were a baby back on Albedo? I lived out of that short-range transport for months, waiting for the official contact team to arrive. At first it was hard being away from my own species, but by the time they got there, being with you and Shurza and Dareem felt natural. And the hard part was dealing with humans again."

"Because we're the best!" Kipparou declared with small-child zeal, raising her hands in the air.

Becca laughed. "No, sweetie—because I adapted. The whole point of intelligence is adaptability. But it can be hard work, so sometimes people need a nudge."

Kipparou pursed her feelers thoughtfully, an expression she'd picked up from Shurza. She lifted the binoculars and watched for a minute before setting them aside again.

Kipparou lifted one hand near her head and flicked her index finger upward in the human sign for *understand*. "You're making Jeph and Tem adapt."

"Human history's full of evidence that it's easier to dehumanize someone if you don't speak their language," Becca said. "It's time to take the crutches away and see if they can walk on their own."

"But it's going to be a very long walk. Shurza can't even read lips like I can," Kipparou pointed out.

"Plantigrade conversations last for years. If we—humans and Albedans—can find the patience to speak with them, we can find the patience to learn how to speak with each other."

Kipparou blinked at her, pondering this for a minute. "Do you think we can do it? Can we talk to the plantigrades?"

Becca pulled her daughter close. "To develop language, you need to have social bonds first. Love is a prerequisite. And in my experience, that's enough to build on." ■

The Kroc War

Ted Reynolds and William F. Wu

Private Erich Zoccola

On the way out to the warzone in the troop transport, Sergeant Libke told us how alien the Krocs were to humans. “No way we can get along with creatures like them,” Libke said. “Ain’t no meetin’ ground between human and Kroc minds.”

“I don’t know, Sarge,” I said. “Why do we call ‘em Krocs, anyhow? They’re not like crocodiles, not really. If it was really a matter of alienness, we’d be going off now to fight the Paregoor, or those energy constructs near Spica.”

“No way,” Jennie Bennoit protested. “Those things stay at home and don’t bother anyone. The Krocs just swooped down and wiped out three Earth colonies to the last baby.”

I grinned at her triumphantly. “They’re just too damned much like us.”

I didn’t like the look she gave me.

Private Jennifer Bennoit

After all those long, black, empty months in hyperspace, the planet blossomed out

ahead of us like a brilliant flower in the black starscape, visible to us on the ship’s video monitors. At last we took up orbit around the planet. All of us grabbed every chance we could to look at that solid gem beneath us, a blue and green and white oasis against light years of nothingness. We watched the nighttime sparks of its cities and the curving rainbow rim of its sunrises.

Then the old man gave the order, and we went in and burned the entire land surface to a blackened crust.

Sergeant Herman Libke

So, yeah, when I was a kid back on Europa was when I saw my first Kroc. I mean, was I impressed! I didn’t care how ugly he looked; these things had traveled the stars, populated all those planets, and carved out the most humongous empire ever. I wanted to talk to him.

So I just went up to him there in the corridor, and all I said was, “Say, tell me what it’s like out there in space.”

And you know, he looked down that snout of his and said, real nasty-like, “Earth-brat, you humans learn how to get along with each other, and maybe how to think a bit, and then in a few hundred years, maybe you’ll be ready to talk to a Krocerian.”

That’s how they all are, beastly and arrogant. That’s why I hate ’em, since you asked—and it’s why the Universe will be better off without ’em. Not my fault, you know?

Lieutenant Roland Lu

In flight school, I just couldn’t get the hang of flying the solo-ships. Even with all the virtual reality the service could muster, I simply didn’t react the right way. Maybe my body told me I was sitting in the pilot’s seat, even when the V.R. system tried to convince me I *was* the ship. I couldn’t risk endangering anyone else, so I was dropped on my request from solo-ship training.

Instead of flying into combat, I got posted to the rear with klutzy surgeons, engineers with poor geometry, and our top admirals.

Private Quatral Zybon

You cannot pretend otherwise: War remains the most atrocious blot on civilization. Even when war becomes unavoidable, it is yet a terrible wrong. However, I know war is sometimes not a matter of choice.

When the news came of the alien attacks on Nwagaur and Trymeith, when the brutality and intransigence of the enemy became apparent, I knew that whatever my personal feelings and abstract convictions, I would have to enlist. So I have joined the Defense Forces, to help protect the enduring values of Kroceri from the barbarian creatures of Earth.

Corporal Fredwin Talaska

I think Libke in his anti-Kroc fury and Zoccola with his indiscriminate pacifism are both fanatics. One would wipe out a platoon of humans to kill a few Krocs and the other would do the same to spare them. But Erich

Zoccola irritates me more, because he comes on like the great humanitarian.

Zoccola went through a tight squeeze recently. He hesitated to extricate himself at the cost of “noncombatant” Kroc lives, and lost eight of his troops—people I knew and liked and fought with. I’d take care of my troops at whatever cost to the enemy. My responsibility lies with those who trust me and the world and species that gave me life, and I just can’t see it any other way.

So Zoccola thinks of me as a murderer. And I think he’s one.

Ambassador Hiram Favio

The cetaceoid beings who inhabited the worlds near Algol lay in an extremely crucial strategic position, so I was sent to persuade them to drop their neutral stance and back the forces of humanity. I was granted an audience with their central council on the Northern Ocean of their home world. Conditions required that I sit in an air-filled chamber while the members of the central council swam up and down behind the glass. I expatiated on the unpleasant behavior of the bestial Kroc species and the benevolent intentions of humanity.

When I had finished my prepared speech, the First-Among-Equals asked me, “What would be your response to our refusal of full support for your war efforts?”

“The ships will come and sterilize this world; your seas will boil into your skies,” I told him.

After due consideration, the central council opted for the benevolent offer extended by humanity.

Doctor Simon Randazzo

They bring them in. I patch them up. That’s what a doctor’s for, and experience has made me very good.

Few of them are brought in whole, of course. If they were whole, their minor parts could be rebudded at the front. Often I find it necessary, when in a hurry, to make use of two or three partial soldiers to make a complete one. Major rebudding takes time.

Some elements remain irreplaceable, but not as many as in the old days. Limbs needn't be natural at all. They're usually more effective for a soldier if they are not. Internal organs take time to rebud, but there's no medical difficulty with the procedures. The composite gets one mind to share.

We always get back to the mind. A large percentage of the fighting force have artificial brains in more or less natural bodies, but these are always the least efficient soldiers, and are returned most often for repair. Yet as the war goes on, more of these are created all the time.

In wartime medicine, the most talented medical staffs remain confined by lack of proper conditions and equipment. The service pays well and steadily, but sometimes I'd rather be back in private practice orbiting Mercury. Still, I guess the questionable working atmosphere comes with the trade of being a healer.

Private Jennifer Bennoit

I cornered Herm Libke after his tenth mission without a scratch.

"How do you do it?" I asked him. "You've never been wounded on any of your runs, while the rest of us are getting shattered all around you. I've lost both legs and an arm at one time or another, a lung twice, an eye. I'm three-fourths rebuilt. And you just somehow always come out of it sweet as a lilac. What's your secret?"

"Wouldn't you just like to know?" Libke grinned slyly. "Sorry, Jennie, but the secret's all mine, and I mean to keep it that way."

Well, I kept after him, but I couldn't wear him down. He never did tell me his secret—and now I'll never know, since he never came back from his eleventh mission.

Lieutenant Roland Lu

Sure, I saw how they changed. Jennie, Fred, the sarge, all the rest—we had traveled the same troop transport to the front together, before I wound up at the rear echelon. I liked to welcome them back when they rotated to the rear for R&R or medical treatment.

As the war wore on, their faces aged and tightened. They became wary, as though the rear held unexpected dangers for them just like the front. After a while, they greeted me as just another office guy, not as a comrade in arms.

I hadn't been where they had.

Corporal Fredwin Talaska

You must understand the orchestration of a full-out assault on an asteroidal base. Over half your ships can be drones but they don't respond as well as human pilots. You still have, say, a thousand piloted solo-ships arrive at a distance of several light seconds, zeroing in on the asteroid. Those pilots have to give orders to drones if they can, or just let the robot brain handle them. The first salvo from the base neutralizes maybe a third of those ships, vaporizes most of them and knocks some others out of action with partial strikes. Maybe the salvo just forces some ships to swing too wide to focus fire. Then the base concentrates on the remaining ships, which have closed the distance, and fires another salvo. Within a minute or so, either the live ships have vanished, or the base has. It's all very statistical.

In my own first assault, we hit Kroc Base 823 at Alphazel B. My outer hull was holed in the first salvo, but by some trillion-to-one fluke, I remained alive, and my inert ship held course near the base. That salvo mistimed the rest of the assault force, but I just drifted in, dead to all seeming, and blew 823 to space dust.

None of those stupid drones ever thought of it.

Well, I wasn't going to trust to that kind of luck again. After that, I did it on purpose. I rigged my ship to cut energy and drift on the first salvo, even it didn't hit anywhere near me; I even set a false compartment to explode, scattering fake debris.

So I personally wiped out the next two bases we hit. After that, some Kroc survivors must have caught on, and then the maneuver became a basic part of assault tactics on both sides, especially once the drones had been programmed with it. But I was the first to think of it.

Senator Lydia Chang

"What's the Kroc War really about, Senator?"

"About eighty light-years across, and about three generations long."

Captain Clyde Santhony

As Admiral Tyler's aide, I stood at his elbow while he fought the second battle of Carinae. Our fleet had been fully vaporized in the first clash there, and Admiral Tyler could only bring us back with a limited force, nearly all piloted; we were running out of drones. His instructions to the new task force went out to all the little ships, and the representative sparks in the plot tank zigged and zagged according to his will.

I watched spark after spark blow out in a dying flare, and wondered which of them had been men and women I had known. We clearly seemed to be taking the worst of it. I figured this task force, too, would be lost. Without any warning to me, he pulled that brilliant maneuver, enticing a horde of Kroc ships in close to a handful of ours, and then annihilating the whole cluster with an unexpected nuclear implosion.

"Neat, eh, Clyde?" The admiral nodded at the darkened plot tank. "Eight thousand, five hundred of theirs and only three thousand, two hundred and one of ours. War of attrition, Captain—war of attrition."

Then I shot him.

As I told the court-martial board, I can't imagine why I did such a thing. Temporary sanity, I guess.

Lieutenant Roland Lu

I applied again for solo-ship flight school when I heard about Carinae 2. Even if the service didn't admit it, they would need a new pilot for every one lost. Robotic factories built new ships faster than the service could train pilots, but the drones had not done the job in the battlefields of space. They were—to use an archaic term—cannon fodder. And decoys. Space junk that got in the enemy's way.

This time, I scored better than before, but I don't think I'd improved. The service needed more pilots in service, and fast. They had lowered their standards without letting on.

This time, I didn't request to be dropped and they pretended my score was terrific.

Lieutenant Erich Zoccola

After the assault on cis-Vega, I simply didn't rejoin the fleet. I went straight on, as far as my solo-ship's fuel would go, and then I set down on an uncharted satellite. By then, I wouldn't have cared much if it were barren or deadly; I was sick of life anyway.

The place turned out to be lush and beautiful and untouched by Kroc or human. It held native beings, too: quiet, friendly little creatures who took a liking to me, lord knows why; they showed me what to eat, bought me gifts on occasion, and otherwise left me alone. I told them how to do a few useful things, taught them some rudiments of science, but didn't push it too far.

I think sometimes they tolerate me because they believe I'm a sort of god.

They don't have any weapons, and I decided to forget what I ever knew.

*Search & Destroy Drone Scout
Programming-04Y-CINCOSOF—detail*

If planet ident. confirm., goto 74
 74. Readout prmtrs alien ident. locus 1000110
 If Prmtrs less than 4.5, goto 75
 If Prmtrs greater/equal to 4.5, goto 76
 75. Readout scan add. planet. bod.
 If locat., goto 72
 If no locat., goto 56
 76. Destroy planet
 Goto 75

Private Sharek Prucka

Well, I guess I can admit it now.

I was posted on scout duty near the Eridani stars as part of the Solar System's far-flung early-warning defense system. Posted and forgotten. For years I hung out there,

kept alive and healthy by my conscientious ship, with nothing to do but watch old movies and think about eternity.

At a time without morning or evening, in my fifth year, a warning tone called me to my console. A fleet of Kroc ships was passing through the immensities in the direction of Earth. My little ship was too tiny, distant, and shielded to be noticed, but this massive invasion of my own private quadrant of the galaxy irritated me intensely.

However, after some hours, the Kroc fleet had passed on. I thought about them for a few moments, and then went back to watching my old movies and thinking about eternity.

beta-Jennifer Bennoit

When they spoke of the duty of saving the galaxy for humanity, Jennie Bennoit listened. She flew out to the border marches as a common soldier. Altogether, she took part in thirty-six raids on Kroc planetary bases. Caught behind the lines on the thirty-fifth, she managed to escape and rejoin her unit despite serious injuries. The docs rebudded her organic parts and patched her back together yet another time and sent her into action again. She was slain during the defense of Callisto.

My own existence is a repayment for her services to humanity. I live in a radioactive warren under the bombed out ruins of Southcal, left smoldering after Earth's defense fleet and orbiting bases destroyed the Kroc armada in a tremendous but surprisingly short engagement. Unemployed and unemployable, I am not allowed to vote or use public transportation. I wish I could have told Jennie Bennoit she was fighting on the wrong side in the war; I like to think she had been sincere enough to care.

For all their ferocity, the Kroc never were known to discriminate against their own beta-creations.

Major Fredwin Talaska

When I got back from my mission to the Kroc capital world, I was praised by my

commanding officer, decorated by the fleet commandant, and promoted by special order of the world president. On my return to Earth, I was lionized, canonized, and paraded; now that the war is settled, I'm a nominee for the Earth Congress from the New Humanity Party.

I think all this is great, of course; I'm as pleased by adulation as anyone. This may sound immodest, but I think I'll make a damned good legislator. I wouldn't put even the presidency out of my reach some day. There are worse things than being a hero, I suppose.

Still, I wish there'd been another way to get here than by annihilating, at one shot, more sentient beings than any other individual in history.

Lieutenant Roland Lu

I get in the new, two-pilot scout-ship and let them attach me up to all the V.R. circuitry that makes the ship an extension of my own muscles and will. Post-war cooperation has enhanced military technology immensely and I can really fly this hot sliver of composites and metal. My co-pilot, Grustra Xybon, is already similarly hooked up to the weapons system.

Just before launch, I look at him and wink. "We make a hell of a team, Grush. Antares just better look out."

"Antares does not listen to reason; Antares will listen to force," Xybon intones deeply, looking down his snout at me. "And you and I, Roland, we have the force to show them."

"You got that right, pal," I say. "Between us, we can lick their whole rotten Antarean Complex. Let's go."

I wonder, briefly, about beta-Roland Lu living under the rebuilding rubble of Southcal. I heard he has a friend named beta-Jennifer Benoit. Maybe they'll be happy together.

They can both go to hell—but they're already there.

I lift the ship, and the first raid on the Antarean Complex by the Human-Krocerian Interstellar Peace Enforcement Control has begun. ■

ODDS & ENDINGS

What an astounding coincidence that the end of my Alternate View career should come with my final column appearing in the 1,000th issue of *Analog/Astounding*! I mean, what are the odds? Here's how it came about . . .

I'd been kicking the notion around in my head for the last few years that sooner or later my run as half of the Alternate View team would come to an end. When I started writing these columns in the late '90s, to my mind there was no certainty that *Analog* would even be around in another three or four years. The internet was taking over everything (it assured us), people were not reading anymore, SF magazines would die out, and so on, blah blah blah. Yet here you are, reading this, holding issue 1,000 in your hands, perhaps in electronic form. Anyway, sometime during the writing of my recent Tesla two-parter, I realized that, in my heart, I knew it was time to relinquish this seat and go on to, and back to, other things.

Since "Blast From the Past Part 2" would appear in the January/February 2015 double issue, I decided I'd finish out 2015 and retire after my November column. I made a short list of what I most wanted to write about, from which I'd select my final four AVs. As I mentioned in my April column, looking into all things Tesla led me to Armstrong, so I already had one topic set. With the November column being my last, that would be my goodbye. This left two.

Having made such a big deal about it almost from the beginning of my tenure, I felt one column should be devoted to the aether. For years I've been collecting online articles as I come across them that describe experimental results; some of which, I think, the future will judge to be the experiments that brought aether

physics back into the mainstream. For instance, the discovery at RHIC that the "quark-gluon plasma" is really a superfluid, to me, is a dead giveaway that the aether is real. Picture me tapping my foot and checking my watch, waiting for the mainstreamers to figure out that RHIC doesn't make the superfluid, but rather, *reveals* that spacetime *is* a superfluid. That column's title would have been "The Stuff That Stuff Is Made Of." But upon reflection, I realized one column, or even two, wouldn't be nearly enough to cover the subject.

Don't be surprised, however, to find that title on a future fact article.

Another column I'd been planning to write would have offered a refutation to the atheism in that essay Jerry Olition published in *Analog* a few years ago ("What Science Means to Me," January/February 2012). The piece annoyed me because I feel that anything that appears in *Analog* plugging an atheist worldview should rise above the Dawkinsesque level of assassinating straw men, but it didn't. I should have penned my rebuttal soon after Jerry's essay appeared, but I wanted to research contemporary examples of "Is there a God?" arguments. Had I done so, I could have kept my strident alternative views limited to one column. But the INTP in me took over; I delayed and read too much, becoming enamored of scholastic metaphysics in the process. . . .

Well, that one would have to be a two-parter, too.

Don't expect to see an essay from me on this topic, though. I can't argue my view better than St. Aquinas, and my essay would essentially be references to what others have already said, only better than I ever could. Who'd want to read that?

Eventually I realized there was no particular reason, other than a kind of OCD appeal, to

retire at the end of the year. After all, I was still at work on part two of the Tesla column, and I already had Armstrong slotted after that. Why not just tell Trevor that my April column would be my last, and say goodbye at the end of that one? So that's what I did. In reply, Trevor said that wouldn't give him enough time to find a replacement, and more than that, the June *Analog* would be the 1,000th issue.

I wasn't going to miss out on *that!* (Lucky thing, too. My Armstrong offering should have been a thousand words longer. I had a terrible time cramming it into one column. My farewell would have been limited to something like the Douglas Adams dolphins' "so long and thanks for all the fish.")

The November 2013 AV was an interview I did with myself. One question I should have asked but did not is this: "If you had to pick one contemporary SF author you wish you could write like, who would it be?" The answer is Jack McDevitt. (Coincidentally, Jack's story "The Eagle Project" immediately follows my AV in that issue.)

Not long after my own stories began appearing in *Analog*, I read Jack's novel *The Engines of God*, the first in his Academy series. I loved it and sent him one of the very few fan letters I've written, suggesting that it needed a sequel. Jack replied saying he had no plans for a sequel (let alone a series), but was pleased that a member of the *Analog* Mafia enjoyed the story. Wow! He knew *me*. We were friends from then on. Though we've met in person only a few times (and they were good times, particularly Kansas City!), he feels like a part of me.

Jack's latest book is an Alex Benedict tale called *Coming Home*. That's the way I feel whenever I sit down with one of his books—like I'm coming home to an old friend, even when it's a new story, even if it isn't part of a series. When feeling stressed, some people resort to "comfort foods" they eat to give them a sense of well being. I have comfort books. One of these is the Heinlein juvenile *Starman Jones*. I first read it in eighth grade, have reread it many times since, and it never fails to settle me down and restore my sense of perspective. All of Jack's novels do that very same thing. For an author to write SF that invariably

makes me feel like I'm "coming home," even when the story is still hot from the presses, is an astounding thing (amazing and astonishing as well).

If there is one knock on Jack McDevitt stories, it is that they lack "futuriness." What is lost on those who do the knocking is that almost all of the best science fiction is like that; see Asimov, Heinlein, and Clarke. I've always liked that Jack's stories contain characters who are people I can understand and relate to, keeping them from interfering with the *story*—every one of which grabs me on the first page and won't let go until the last.

Quite simply, Jack McDevitt is an awesome guy who knows how to tell great stories. Of his books, I can safely say that in one way they are all the same; they are all good. I can say that of no other authors I'm as familiar with, including Asimov, Heinlein, and Clarke.

Who wouldn't want to write like that?

So what will I do now that my AV days are over? How will I fill the time that I used to put into reading, writing, thinking, revising, procrastinating, and deadline flouting? Write fiction again, for one thing. I don't know how it works for others, but writing fiction and writing nonfiction are very different mental processes for me. I can bang out fiction a mile a minute because I make it up as I go along. It's easy when I can always fix it later, on my own schedule, if something unexpected comes along, like my characters escaping from me. If I like where they're going better than where I intended to send them, I'll keep that and revise away the conflicts with the earlier draft. That's *fun*. But in writing nonfiction, I'm stuck with reality. And because of deadlines, I have to be careful not to waste time going down a wrong path. With Alternate Views, I have to cram everything into less than two thousand words. It's much easier for me to write an AV to the right length the first time than it is to chisel it out of a too-big block of prose. I can slice off 10% of fat and 2% of lean, max; if I need to whack 20% out of a first draft, then I've screwed myself.

Once I turn in this column, late as usual, it will be the first time in two decades that I will be completely deadline-free, and that feels pretty good to me. It's what I needed.

Apart from story writing, I'll also blow the dust off my lab bench and return to tinkering. I've been doing a little bit here and there all along, but it's been a very long time since I've had the freedom to immerse myself in an experiment or work on an invention, whether one of my own or an interesting gizmo I spotted on YouTube.

If you follow me on social media, you may find me arguing more, and with the gloves off. You see, as an *Analog* regular, that makes me "associated with" the magazine, even someone who "speaks for the magazine" in the minds (wrongly) of many, even though all my words and thoughts are strictly my own. Few and far between are the times either Stan or Trevor asked me to change something in an Alternate View, and when they did I agreed with them. And yet, as a fixture at *Analog*, I've been reticent to express myself too stridently online, sometimes even to avoid a fight, feigning modest respect for opinions that, in all honesty, didn't deserve an ounce of it.

I'm all for being nice, and I enjoy polite discourse. I'd never deliberately go around hurting feelings. But the next time one of my writer buddies is ambushed online by an unhinged Social Justice Warrior (SJW) I will no

longer hold back in his or her defense. Sometimes bullies merit rhetorical dismemberment for the enlightenment of the onlookers, and a decade of restraint is enough. So don't be shocked if sometimes you see me go all ninja on someone's ass. It is, after all, a dangerous world, more so now than when I started writing the Alternate View. The Pollyannaish approach of putting feelings on par with a true appreciation of the nature of the world, so typical of SJWs, is incompatible with the long-term survival of our species. I aim to eradicate it.

In closing, let me say thank you to Stan, Trevor, and Emily for being there with me, and for me, and knowing how to handle my INTP personality. Let me also thank my readers for being pleased with me, or frustrated, or angry, or delighted, just so long as I prompted you to think. I sincerely hope whoever takes my place will love the job as much as I did, and rest assured that my shoes are size eight and not too big to fill. Finally, let me leave you with this (Buelleresque) aphorism: It's a science fiction world out there. If you don't stop and look around once in a while, you might miss it. ■

John W. Campbell, Jr.

Ben Bova

When he died unexpectedly in 1971, John W. Campbell, Jr. was the towering editorial figure who had dominated the field of science fiction for more than three decades. In recent years, Campbell's reputation has been eclipsed by the continuing evolution of the field.

Even so, to a considerable extent, modern science fiction is the creation of Campbell's editorial genius. What we call science fiction today is a literature that reflects Campbell's ideas of what the field ought to be.

Forgotten in today's dynamic, growing science fiction realm is the fact that it was Campbell, starting in 1937, who insisted on high-quality writing for science fiction stories. The first steps in leading science fiction out of the formulas and dreadful writing of the pulp magazine industry were taken—forcibly, at times—by John Campbell.

The title of the magazine he edited from 1937 until his death reflects his own goals, and the evolution of the field. When the 24-year-old Campbell was given the editor's job, starting with the December 1937 issue, the magazine was titled *Astounding Stories*. By February 1938 Campbell had changed the title to *Astounding Science Fiction*, and over the next

twenty-two years, he insisted on cover type that emphasized "science fiction" and downplayed the melodramatic "Astounding." Finally, in 1960, when publisher Street & Smith was bought out by The Condé Nast Publications, Campbell was at last allowed to change the title to the one he had wanted for decades: *Analog Science Fiction & Science Fact*.

Many contemporary writers think of Campbell as an eccentric who championed a variety of crank ideas, from dianetics to libertarianism. A chain smoker, he refused to believe the Surgeon General's report on the links between smoking and heart disease—a refusal that may well have cost him his life. He was a great arguer, in the Socratic sense, and enjoyed nothing more than convincing a skeptical audience of his point of view.

His editorial crotchets, especially in his later years, are well-remembered. Few now recall, however, that his primary goal—stated boldly early in his career and then more and more by implication as the years rolled by—was to fill his magazine with what he considered to be "good stories."

How did Campbell define a "good story"? I believe he used three main criteria: technical background, mood, and writing quality.

Clearly, he insisted that the technical background of each story be based firmly on what is known of scientific fact and principles. In this, he set the basic rule of modern science fiction: The writer can invent anything so long as no one can demonstrate that it is physically impossible.

To cite one famous example of the result of Campbell's policy, stories dealing with nuclear weapons began appearing in the pages of Campbell's "Astounding" long before the first atomic bomb test at Alamogordo in 1945. The most famous of these was Cleve Cartmill's "Deadline," published in May 1944.

The story described the way the first atomic bombs worked so accurately that the FBI investigated the genesis of Cartmill's story, fearful of a security leak in the Manhattan Project.

Many latter-day critics have decried what they believed to be Campbell's insistence on "gadget" stories. They claim that "hard" science fiction, concentrating on stories that deal with technology and the physical sciences, limits the writer too much. The claim may be true, but the implication that Campbell restricted the pages of *ASF* to nothing but gadget stories is demonstrably false.

Consider the atomic bomb case again. More than four years before Cartmill's description of an atomic bomb was published, Robert Heinlein wrote "Solution Unsatisfactory," which appeared in the May 1941 *ASF*.

"Well," I answered, "what of it? It's our secret, the atomic bomb, and we've got the upper hand. The United States can put a stop to this war, and any other war. We can declare a *Pax Americana*, and enforce it."

"Hm-m-m—I wish it were that easy. But it won't remain our secret; you can count on that. It doesn't matter how successfully we guard it; all that anyone needs is the hint . . . and then it's just a matter of time until some other nation develops a technique to produce it. You can't stop brains from working . . .

"It's like this: Once the secret is out . . . the whole world will be comparable to a room full of men, each armed with a loaded .45. They can't get out of the room and each one is

dependent on the good will of every other one to stay alive. All offense and no defense. See what I mean?"

Heinlein (once described by Algis Budrys as "the hand of John Campbell's mind") correctly described the political implications of nuclear weaponry: the Cold War stalemate between the superpowers, the state of nuclear terror that held the world in its thrall for more than forty years.

Few critics have seen beyond the gadgetry in the pages Campbell edited to understand that *ASF* pioneered the way for stories dealing with the social, political, and human consequences of new technology. Far from restricting the pages of *ASF* to "hard" science fiction, Campbell educated the readers—and writers!—to consider the "softer" sciences of sociology and politics, as well.

It is no secret that Campbell did prefer "up-beat" stories. He had little tolerance for weaklings or failures. His preference was based on his belief that the human animal is admirable, that rational thought—as exemplified by science and engineering—is our main method for dealing with the environment in which we find ourselves. He was certain that Man is the toughest critter in the forest, and to those who did not believe it, or who felt there is something wrong or evil in such an attitude, he showed scant patience.

In this, Campbell clearly fell into the ranks of the philosophical optimists. He would have laughed at the myth of Sisyphus and immediately started to sketch out a system of pulleys that would allow that tragic mythical figure to get his stone over the top of that damned hill.

Does this mean he automatically rejected "down-beat," pessimistic stories? No, as a glance at Tom Godwin's "The Cold Equations" (August 1954) will show.

In this story, a young woman stows away on a space ship carrying the desperately needed vaccine to a plague-stricken planet. She wants to reach her brother, who is one of the plague victims. The ship's pilot, its only crewmember, discovers the stowaway and realizes that her extra weight will prevent the ship from reaching its destination. He decides that the lives of millions of plague victims outweigh the life of the stowaway, and forces her

out of the airlock, to die in the vacuum of space.

The theme of the story is classical: The Universe (or what the ancient Greeks would have called Destiny) does not care about our petty loves and desires. One and one inexorably add up to two, no matter how desperately we would have it otherwise.

Beyond his insistence on scientific plausibility and his philosophical attitude, Campbell demanded writing quality much higher than the pulp fiction that preceded his reign at *ASF*. There were only a few science fiction magazines being published in the late '30s and throughout the years of World War II. Campbell consistently paid the best rates in the field and consistently was the first editor to whom a writer sent each new manuscript. He used this powerful position to pick the stories that he considered best, and the quality of the writing was an important criterion, although usually an unspoken one.

Yet consider what was published in *ASF* before Campbell. I picked two stories at random: "Redmask of the Outlands," by Nat Schachner, and "Star Ship Invincible," by Frank K. Kelly. They were the lead stories in the January 1934 and January 1935 issues of *ASF*. The magazine at that time was considered among the best in the field. Schachner was a regular contributor who had 57 stories published in *ASF* between 1931 and 1941, several of them under pen names because he often had more than one story in an issue. Kelly had only three stories in *ASF* in 1934 and '35.

The opening lines of Schachner's "Redmask of the Outlands:

The city-state of Yorrick was a huge cube of blackness on the shores of the ocean. On one side stretched the interminable Atlantic, billowing and sun-bright; on the other, the almost interminable forests of the Outlands. In between lay a sudden cessation of light, of matter itself—a spatial void of smoothly regular outlines.

The oligarchs of Yorrick had build- ed [sic] well to protect themselves and their millions of subjects against attack. Against the warped, folded space that inclosed [sic] the three

levels of the city, powered as it was by the gravitational-flow machines, the most modern offense was impotent. No weapon conceived by man could break through.

And the opening of Kelly's "Star Ship Invincible:"

He had been sitting hunched on the high stool of the operator's chair, elbows on the smooth ledge of metal that encircled him, when the receptor tube spat a harsh sound in his ears, a sibilant warning note. He thought, "What now!" but straightened with alacrity, his stiff back shaping a tense angle.

He jerked his head upward in an arc, nostrils widened, his thin nose slightly trembling, as if he could smell what was vibrating through the receptor channel. He forgot how cold he was, and how his stomach ached faintly from many days on a diet of compressed-food tablets, and how he wished his relief would come, because he was lonely, the universe seemed strange and hostile all around him.

It took many months before Campbell used up the inventory of stories that his predecessor (now his boss) had accumulated, and even longer before he began to get the kind of stories he wanted to publish. Here are the opening lines from the lead stories of the January 1940 and January 1941 issues of *ASF*.

The first is "Neutral Vessel," by Harl Vincent:

In the captive military observation sphere a hundred miles above the outer cloud layer of Venus, Tommy Blake idly punched a location spot on the calculating board. He was not greatly impressed by the alarm indication of this body's approach. Seven million miles it was off, at the limit of the sensitive magnetic pickup system. From its direction, it could hardly be a Martian battle fleet, and even if it were, they would be several days getting here. Plenty of time.

* * *

The January 1941 lead story was "Sixth Column," by Anson MacDonald (Robert A. Heinlein), an acknowledged masterpiece. Its opening lines:

"What the hell goes on here?"
Whitey Ardmore demanded.

They ignored his remark as they had ignored his arrival. The man at the television receiver said, "Shut up. We're listening," and turned up the volume. The announcer's voice blared out, "—Washington destroyed completely. With Manhattan in ruins, that leaves no—"

There was a click as the receiver was turned off. "That's it," said the man near it. "The United States is washed up." Then he added, "Anybody got a cigarette?"

The contrast between the stiff, stilted prose of 1934–35 and the more naturalistic and engaging style of 1940–41 is no accident. Schachner and Kelly were still writing in the early 1940s, but Campbell did not buy their work.

Instead, he sought writers who not only had real experience in science and engineering, but who could also write smoothly and naturalistically. He wanted writers who had "been there," at the edge of modern research and engineering, and who could write out of personal experience of the kinds of people and situations that existed at those frontiers.

As he himself often put it, "I'm looking for stories that could appear in the 'slicks' [i.e., *Colliers*, *The Saturday Evening Post*, et al.] two hundred years from now."

The "slick" magazines have died away, but Campbell's science fiction is a powerful, dynamic field of contemporary literature.

The pantheon of science fiction's 1940–1960 Golden Age is filled with writers Campbell published in *ASF*: Poul Anderson, Isaac Asimov, Hal Clement, L. Sprague de Camp, Lester Del Rey, Gordon R. Dickson, Harry Harrison, Robert A. Heinlein, Henry Kuttner, Murray Leinster, C. L. Moore, Clifford Simak, Theodore Sturgeon, A. E. van Vogt, Jack Williamson, and many others.

The prolific Robert Silverberg started his career in *ASF*. While every book publisher in

New York rejected Frank Herbert's novel *Dune*, Campbell serialized it despite the fact that it was twice as long as ordinary magazine serials of the time. The tremendous reader response to the novel created the audience for the book's eventual publication—by a textbook publisher in Philadelphia.

No one read the manuscripts submitted to *ASF* except Campbell himself. There was no "first reader;" he read them all, those sent in by agents, those from the best-known writers in the field, and those from the unknowns. It was particularly that enormous flow of manuscripts from previously unpublished writers, called in the trade "the slush pile," that Campbell mined for gold. There he discovered the new talent that made his magazine—and the field—great. He gave up his own not-inconsiderable writing career and spent the rest of his life reading manuscripts, frequently for twelve hours a day or more. For 34 years.

He was inordinately kind to young writers. His letters, even his rejection letters, are legendary for their richness of helpful ideas and encouragement to "try again." The most famous example, of course, is the teenaged Isaac Asimov, who all his life gave Campbell the major share of the credit for his success as a writer.

Campbell often said, "The real job of an editor is to find a good writer in a bad story." That is, to recognize talent in a beginner's clumsy efforts. And then to encourage the beginner until he begins writing publishable stories.

By the 1950s, new science fiction magazines such as *Galaxy* and *The Magazine of Fantasy and Science Fiction* began to appear on the newsstands. Book publishers started to take science fiction seriously. They all built on the foundations that Campbell had constructed. Even those editors and writers who decried "Campbellian" science fiction as too restricting and old-fashioned were (perhaps unknowingly) taking advantage of Campbell's many years of labor and the audience he had built up.

The quality of science fiction writing was unquestionably higher in 1950 than it had been in 1937. More than that, the readers had been trained in the pages of *ASF* to expect and demand writing that was much better than the earlier prose of the pulp magazines. These expectations and demands increased as the

decades rolled on. The “New Wave” of the late 1960s and the burgeoning of science fiction in the ’70s and ’80s were the inevitable consequences of the evolution of science fiction away from the pulp magazines and toward a true contemporary literature. Campbell played the pioneering role in that evolution.

Perhaps the most revealing incident in Campbell’s long career came immediately after he was appointed editor of *Astounding*. He asked a senior editor at Street & Smith, “What happens if I don’t get enough stories to fill the magazine?” The older man fixed him with a stern eye and said, “A *good* editor does.”

From that moment on, Campbell spent his enormous energies making certain that he could fill the magazine. His hackles-raising editorials, his voluminous correspondence, his long hours of reading manuscripts, his marathon arguments over everything and anything from quantum physics to slavery to the Dean Drive—all were aimed at making certain there would be no blank pages in *ASF*.

More than that, he wanted to fill the magazine with *his kind* of stories: technically acute, upbeat, and well written. He succeeded far better than anyone before or since. What we call “science fiction” today is what John W. Campbell determined the field should be. ■

IN TIMES TO COME

So how do we top an issue like this one? Well, a two-fer is a good start. In next month’s July/August double, we kick off with the first installment of a serial—and not just any serial. New planets bring new opportunities, but when unexpected complications arise, how do we keep from making the same old mistakes all over again? Find out in Stanley Schmidt’s *Night Ride and Sunrise*. Then we have a pair of fact articles: Edward M. Lerner’s next entry in his ongoing series, “Alien Altercations: Star (Spanning) Wars,” as well as a smaller, “crunchier” piece from Robert Zubrin, “Moving the Earth.”

Of course, a plethora of further fine fiction awaits, from Liz J. Andersen’s flea-bitten “The Smell of Blood and Thunder,” to Ian Watson’s slyly shifting quantum entanglement, “Breakfast in Bed”; from Rob Chilson’s Vancian “The Tarn,” to Adam-Troy Castro’s tense thriller, “Sleeping Dogs,” and plenty more in between, as well as a special feature on plotting by Richard A. Lovett, all our regular columns, and the results of our annual Analytical Laboratory Reader’s Awards.

Don’t miss it!

All contents subject to change

Strategies for Optimizing Your Mobile Advertising

Brenta Blevins

My swollen heels already throbbed when my T-shirt flickered, erasing its frenetic neon Shinjuku-shopping-district-meets-Vegas-casino scheme. It reverted to the agency's monotone corporate logo. I tapped the diagnostics scam and got "SEARCHING FOR CONNECTION."

Crap. I squinted against the bright pollution haze above. A fighting kite floated away from the skyscrapers, cut loose by a competitor. Must have been my shirt's preferred carrier.

My shirt fell blank, as gray as an empty slate. Not even a "YOUR AD HERE."

My forehead prickled with sweat. I panted polluted street air faster than was good for my asthma. This was much bigger than simply losing a carrier kite. Of course this was Monday.

I teetered on a concrete planter as my fingers flew over fabric. Maybe some ads remained in the shirt's cache. I swiped the hem. My shirt remained static gray. People rushed past without seeing me, like Neo in that street

scene from the classic *Matrix*.

I massaged my aching heel, trying to ignore this and my larger failure. My mother kept telling family and friends I was in business. True, I guess. When pressed, Mom called me a contractor. The only contracting I offered was a wide, flat chest and the ability to locomote—with no peskily handsome face to distract gazes from advertisements flashing across my clothing. I liked recreating classic art using office supplies as media, calling my artwork "commentary on modern society." Really, trying to sell it was less commentary, more "a poor way to pay bills," unable to compete with trendy electronic art. Mom kept inviting me back home, suggesting trying again, elsewhere, assuring me tastes changed. I didn't want to admit failing here.

No walking, no eyeballs. I got up. My T-shirt didn't vibrate in acknowledgement. Right. No walking, no power.

I traipsed up the sidewalk. If spines spoke,

my vertebrae screamed. The agony of adwalking. But in today's economy, how else could an office supply artist afford his inhalers, let alone earn enough to access his apartment tonight?

The clock tattooed into my wrist pulsed. Crap. I was late to my reserved adwalk in the banking district where I earned serious eyeball hits as specials and menus cycled rapidly over my front and back, and my sleeves shed coupons and promotions.

Grabbing my phone, I called tech support.

"Speak your selection."

"No service!" I jogged toward the financial district's towers, ridiculously hoping movement would reboot my shirt. Crap. I missed sponsor check-ins left and right.

Out of habit, I took up more room on the sidewalk than physics allowed, earning me med and apartment credits. Too many people installed ad blockers on their smartphones and glasses—but they couldn't avoid me. Not when I walked in front of them, circled them—or stood in the middle of the intersection. I sidled across the next crosswalk. Remembering my malfunctioning shirt, I finished crossing. I'd dodged too many license-yanking cops over traffic obstruction tickets.

"Your call is important to us."

The food trucks that licensed me already lined the street. Spicy scents rolled out open windows. Blenders ground beans and ice. Crap, crap.

I looked for other adwalkers. Was everybody down?

I spotted Jayce, Bala, and Gabe sticking to their reserved territories, half to a quarter block from the other, despite the rush to the food vendors. We couldn't get caught fighting, not on camera. We couldn't risk damaging our respective advertisers' properties.

Their shirts crawled with ads.

"Your call is important to us."

I paced. I only had three doses of inhaler left. While most transportation was electric, factories, building exhausts, and a city crammed with people still churned out pollution.

"ShirtTech. How can we help?"

I jumped, then answered a slew of questions. "Yes, my watch has connectivity. It isn't my day off, I didn't launder the shirt or get rained on."

"—transfer you to a senior engineer. Please hold."

"No, wai—" Too late.

If it wasn't carrier-related or technical . . . had

I been fired?

I put my on-hold tech support call on hold and called the agency.

"This is Valencia."

"Serge, here. I—"

"Glad you called. Analytics show you aren't working, but I see you on street."

"Right—"

"You aren't subcontracting, are you?"

"No!"

"All your intrusion software up to date?"

My thoughts raced. I'd signed noncompete, virus, and adware protection agreements with my agency. Obligated to protect myself against exploits, I could lose my advertising license with the city. Had a line-cutting competitor agency hacked me? Maybe Jayce wanted my territory. Crap.

I dreaded the call with Mom. Seeking help, I sprinted toward the very not-OEM, very "off-market" supply alley. Maybe they would trade this shirt for a downgrade. I could hear Mom: "You shouldn't be promoting any products but your own."

Before the alley, I stopped short, well outside optimum sidewalk visibility.

Ahead, a crowd encircled a tall woman whose flesh flashed like an ambulance's lights. Her skin crawled with 2-for-1 promos, 50 percent off coupons, and "GRAND OPENING" ads.

The newest paradigm in mobile advertisement. I took a hit of albuterol.

I gazed across my own skin, marked only with my watch tattoo. Obsolete tech.

My back ached. I had a spare, not-quite-empty inhaler left in my apartment. I checked my phone to see if I'd earned enough credits to get in and get it. No.

The crowd swelled, pushing me against a storefront.

I called Mom.

"I was wondering when I'd hear from you."

"What—"

"I saw the strangest advertisement uptown this weekend. I knew what I needed to do."

I came out muffled against someone's messenger bag. "You—hacked your own son?"

"Whenever we talked, you blocked out my advice."

Blocking—?

"I was worried about you. So I tried a new strategy to get your attention."

I was floating, loosed from my tether, a kite cut from its line. "See you soon, Mom. Thanks." ■

The Odds

Ron Collins

What are the odds that life would exist on two separate worlds? That this life would be born and would grow and evolve past the protoplasmic stage of gum and goo and into beings that lived and breathed and began to think and imagine? That it would, in two places, become mobile and carnivorous and adventurous and curious, and in doing so would build things of such beauty as to take your breath away and of such utility that they would become capable of leaving their home worlds to spread across the entirety of the very cosmos itself?

Surely the chances are low for such life to exist in any single place let alone any single time. But the Universe is infinite, and hence the probability for such a scenario must be presumed to have a level of certainty that cannot be discounted.

Given this certainty exists, what are the odds that these two species would meet in a dark corner of space, parsecs from the homelands of each? And, given that they were to meet, to actually bump up against each other in the distant and vast gaps that comprise the Universe itself, what are the chances that rather than fight, they would instead merely

query each other? What is the probability they would bond and learn to live in tandem?

Certainly, this is not likely, right? Life is struggle, the fittest wins, the most deserving carries on.

Correct?

So given all those permutations, what are the chances that one of those species, one form of life, would merely pretend to get along?

Against this backdrop, we turn our sights inward, and we ask: What are the odds that *you* would be born in that very time period when two life forms from two different worlds were pretending to get along? These are longer odds, are they not? Looking only at your own species, for example, one can estimate 1.9 trillion of your people have been born since its time of origin. Ninety-eight billion of them live today, scattered among the planets. You can do the math. Of course, you could add in the question "why this version of you?" There have been, after all, nearly a trillion women born in the age of your species, each with millions of eggs. A male's ejaculate contains even more sperm cells than a female carries eggs. The potential matches are almost impossible to calculate, and that does not

account for infant design practices that have been common for the past three hundred standards wherein parents prescribe exactly what they want their children to be (seeing as your parents could not afford this practice, however, we will—for purposes of this discussion—ignore the fact that social stigma has dramatically reduced variation since this became the norm).

When examined in this fashion, it becomes clear that the chances of you even existing, better yet being alive at the time of such convergence, are . . . not large.

Given the enormous odds against you even existing, what are the chances that after being born to parents of modest means, you would be plucked out of a classroom yard one day and find yourself in the finest schools? Trained by the most remarkable coaches? Measured and quantified weekly, and, over many years, given the opportunity to earn your prestigious first post in the Intergalactic Ambassador's Office? Which, of course, you did earn. Nothing else would have been practical, correct? Nothing else would have satisfied.

At that point, even the most callous observer would have predicted your rise—intern, assistant to the controller, senior analyst, and finally, the ambassador's role itself. Everyone saw your demeanor, your calculating charm. People wanted to be near you.

You think these thoughts as you prepare for the session, a meeting with the leadership of a collective of creatures who are so foreign to your own, who are considered ugly because of the ridges over their eyes and their sheer cheekbones, who are considered quirky because their arms dangle with such strange function, and are considered depraved because of their proclivity for sexual encounters in unusual places. What, you ask of yourself as you don your ceremonial trousers and kilt—the tartan of your clan embedded into its weave like DNA, are the odds that it would be *your* job today to hide the truth? What were the odds that *you* would be born in this time and place with these skills and that *you* would live your life to achieve this role? The odds that it would be *you* who would meet this second species and be given entry into their culture, be shown their literature and their architecture, be provided insight into their bloody history as they grew

into their compassion, that it would be *your* reports of this history that would cause such concern among your own people? What are the chances that your people would overlook their own bloody past in condemning the past of this second species? And given those odds, what are the chances *you* would find yourself with the task of diverting the attentions of an entire species of sentient beings from the acts of your own leaders—people who were, at this very moment, giving attack orders to the antimatter terrorists, gamma ray gunners, and subspace fighters they had positioned at battle stations across the entirety of the known Universe? What were the odds that your orders would be to stall, to delay, to reassure the leaders of this second species that *your* people cared for them, that *your* people wanted nothing more than to live together in a cosmos that was harmonious and peaceful?

You think about these things as you wash your hands, and splash water against your eyes that have not slept all night.

What are the chances that of every specific entity, of all the unique people, and all the other existences that have ever lived, or not lived, or wished to live, or . . . what are the chances that *you* would be the *one* person in all of existence across all of time who would be asked to perform these functions, that *you* would be the *one* to witness the expressions on the faces of the leaders of this second species as they received reports of the attack? What are the chances that *you* would be the *one* asked to report back to your leaders regarding their surprise?

You know the answer to these questions. The chances are 100 percent. Odds 1:0. There is no going back. What happens, happens.

You look in the mirror, seeing the dashing bearing of your frame, and the way your clothes lay so well across your body. You understand exactly how you came to be here, how *you* came to be given this most critical assignment of all assignments. You know how *you* came to be asked to drive the last nail into the coffin of this, the most galactic of all genocides.

And that leads you to the most important question of all.

What, you ask yourself, are the odds that *you* can actually bring yourself to do this job? ■

The Empathy Vaccine

C. C. Finlay

The place that I call the Monster Factory is located in a high-rise office tower with a blinding glass facade. Normally, it's filled with accountants, venture capitalists, and bankers. But I'm here at 6 A.M. on a Sunday morning, and the place is dead.

Debbie, my wife, thinks I'm away on a business trip. It's not a complete lie. I am here to take care of business.

I park my car in the dim, echoing garage, pop open the glove compartment, and remove the 9mm handgun. After checking the magazine and chambering a round, I slip it into my jacket pocket.

It feels good, like an insurance policy.

You've got to understand: I love science, but I don't trust scientists.

Inside, the building is as empty as a salesman's promise. One elevator and two hallways later, I find the office marked "Cantwell Investments."

My fist is primed to pound on the door when it opens.

Doctor Cantwell stands there, cool and tall. "Kyle Hastings," he says. He's a Versace suit with bleached teeth, wearing a cologne that

smells like a stack of brand new hundred dollar bills. When he offers me his hand, I crush it as hard as I can.

He squeezes back, almost as hard. "Come in," he says, ushering me into a reception area as posh as it is forgettable. When I step away from his cologne, something faint and antiseptic tickles my nose.

The lock clicks shut behind me.

"I was surprised when you scheduled a second appointment," Cantwell says. "Most of the men I talk to decide the procedure isn't for them, either because of the cost or the side effects."

"No pain, no gain." I smile. "You get what you pay for."

His returning smile is as insincere as mine. He gestures me to a seat at a large desk, whose vast empty surface suggests endless possibilities. The gun makes a soft thump against the arm of the chair as I sit down.

"What's there to talk about?" I say. "I want the empathy vaccine."

Cantwell slides into the leather seat opposite me. "Technically it's not a vaccine. A vaccine contains a modified form of virus or a

sample of antigens, which stimulates the body to produce the desired antigens, conveying immunity. Empathy isn't an infection."

I wasn't expecting a lecture. I lean backward. "I know that."

"This is just a quick formal disclosure, something I have to go through." He tilts his chair back. "The procedure you want is a viral gene therapy. A tailored retrovirus is used as a vector to deliver new genetic material into half a dozen target chromosomes that are associated with empathy."

I think *yadda yadda* but I nod.

"For example, oxytocin receptors have nucleobase pairs with either a G, guanine, or an A, adenine. People with G/G pairs tend to show high empathy. People with A/A pairs tend to show low empathy. And people—like you—with one G and one A fall somewhere in between, depending on factors like environment, affluence, and so on. The gene therapy replaces your G nucleobase with an A to make you a low-empathy A/A."

He pauses to catch his breath, and I hope he's done.

"Then we look at your vasopressin receptors, specifically the AVPR1a, or so-called 'ruthlessness gene'—"

"It's okay, I read all the articles you sent me."

"You did?"

"In detail. Every word. Some of it was a little technical"—He smiles with tight lips, then quickly hides it, which irritates me—"but you don't have to know exactly how the sausage is made to tell that it's delicious. The point is that the technology works."

"Yes, in every single patient it's been used on so far."

"So a layman could call it an empathy vaccine?"

"Yes, a layman could."

"And I'm just a layman." I spread my arms, palms open, to show that I'm being reasonable. "Look, I'm a bottom-line guy. And the bottom line is: does the technology work and how much does it cost? It works, and I've got the money, so let's do this."

"What made the difference?"

I cross my arms. "What made what difference?"

"Why did you decide to come back for the procedure? After I described the pain of the

process, the possible side effects, and all the personal costs."

It's a fair question. "I investigated the names of the clients you gave me. Sergio Bonello embezzled over 7.5 million dollars from his company and then disappeared. Matthew Roarke mortgaged his house and vacation home to the hilt, cleaned out his bank accounts, sold all his wife's jewelry, and then he was just gone. Nobody has ever seen either of them again."

"And that convinced you?"

"Yeah. They got the vaccine and started over."

He nods. "People who have no empathy often find it easier to do that. New identity, new city. No emotional ties to the past or to other people." He taps his finger on the desk. "So that's it, you want to run away somewhere and start over? You could do that with the money you're going to pay me. You don't need the procedure."

"No, I'm staying. I know there are others. You can't disclose the names of guys who've taken the vaccine and are still working here in town. Hell, maybe I work with some of them." I laugh. "I bet I've worked for them. But they aren't saying anything to anyone. And if someone asks me about this later, I'm going to deny it too. So, no, I don't want to run away. I just want what's mine."

"And what's yours?"

I shrug.

Cantwell leans forward, as if he's had a sudden insight. "Somebody very recently took something you deserved."

How does he know? He probably checked out me the same way I checked out him. When you're pursuing illegal medical procedures, both sides have to be extra careful.

Not that it matters. "There's no way Karen Richland should have been promoted to senior vice president instead of me. But they had to fill a quota. If I want to get ahead, then I need an advantage. Something that will give me an extra edge. So I've decided to take a little personal affirmative action. And here we are."

He nods. "You understand that the gene therapy won't change your character. You'll still have the same personality traits."

"That's good, because I think I've got some great traits." We both laugh at that. "But seriously, what I want is something like steroids.

A performance-enhancing drug for corporate management.”

“In layman’s terms again.”

“Sure.” I lean forward, because I want him to see how serious I am. “When I was in business school, during exam week, we ate Adderall like they were M&Ms. Nothing’s changed since then.”

“But the effects of Adderall wear off,” Cantwell says. He puts his hands together on the desk. “Gene therapy is an extreme step. If we go through with things today, it will be a permanent, irreversible change to your physiology.”

“Good—I need a permanent change.” I shift in my seat. The guy is a lousy salesman. I feel like he’s almost trying to talk me out of the procedure. “I’m going to be very blunt here, doctor.”

He nods. “That’s the best approach.”

“You need to know that I’ve thought about this, and I’m willing to do whatever it takes.” Even if it means becoming a monster.

Cantwell’s brows quirk, like he heard the part I didn’t say.

I start to doubt his willingness to follow through.

“What about your wife, your three children?” he asks.

“I love them. With all my heart.” I don’t like him asking about my family. They’re none of his business. “I’m doing this for them, so I can get ahead and give them the kind of life they deserve. Everything I do is for them.”

“This will change your relationships with them.”

I nod, like I agree with him. “Hey, I was thinking, maybe I’ll get my son Mike the gene therapy for his eighteenth birthday. A better investment than college, right?”

Cantwell pauses. “Maybe. Depends on what kind of person your son wants to be.”

“He’s just like me. I want him to have the same chances I’ve got. It’s called the selfish gene for a reason.”

“Some are more selfish than others.”

I’m starting to hate Cantwell. “So are we going to do this?” Or are you going to keep dick-ing around with me?

Cantwell reaches into a drawer. I thrust my hand into my pocket and grab the gun.

Cantwell freezes for a second, then slowly pulls out some papers and a pen.

“We’re going to do it,” he says. “Everything is paper only, burner cell phones, nothing that will leave a traceable electronic record.”

My hand slowly releases the gun. “Fine with me.”

I don’t want to leave any records at all. After getting the vaccine, maybe I can shoot Cantwell and take the papers. I’ve never aimed a real gun at a real person before, but I rock *Call of Duty*, and I’m tops in my group at the shooting range. The vaccine should take care of the rest. No empathy, no hesitation.

Cantwell pushes some papers toward me. “I’ll need your signature on these release forms, here and here. Just in case you think about going to the authorities later.”

“Wouldn’t dream of it.”

I sign the forms and shove them back across the desk. Then I reach inside my jacket for my own stack of papers. “Here are the banker’s checks, just as you directed. Different banks, different amounts, hard to trace. Don’t spend it all in one place.”

Cantwell studies the checks and smiles.

“They’re for the full amount.” More than I can afford. Or at least more than I want to spend. I had to cash out my retirement account and all of my investments. I’ll have to take the checks back when Cantwell is dead.

He opens a drawer, but I reach across the desk and snatch the checks out of his hand. I slip them back into my pocket. “I’ll hold on to these until after we’re done.”

“Are you sure you need this procedure?” Cantwell’s smile has disappeared. He looks nervous. I like him better nervous. “It will be very painful for you.”

“Let’s not pretend you care. What’s the next step?”

“Have you had anything to eat since midnight?” he asks.

“No.”

“Then please come this way.”

He leads me down a dim, sepulchral hallway to a bright, clean room with a flat metal slab of a procedure table. I have discovered the source of the antiseptic odor I smelled earlier.

“Undress and put on the hospital gown,” he tells me. “I’ll be back in a moment.”

I hesitate, hand on my insurance.

"Is there a problem?" Cantwell says. "It's not too late to change your mind. You've got your checks. You can just walk out the door."

"I'm not walking anywhere." When I imagined this procedure, the images didn't include me in a paper dress with my naked ass pressed to cold metal table. "This is like getting shot, right?"

Cantwell glances at my pocket. "Getting shot?"

"A shot. Like getting a shot."

"More like running an IV. We're rewriting your genetic code, based on the sample I took previously. It's more complicated and requires a bigger dose than a single shot."

"It's not that complicated. Why can't I leave my clothes on and sit in the chair?"

It's Cantwell's turn to hesitate. Finally, he says, "If that's what you want. I'm going to change."

While he's gone, I shift around in the waiting room style chair until I'm sure I can reach into my pocket quickly if I need to.

Cantwell returns in scrubs and purple latex gloves. "Can you take off your jacket, please? There's a hook on the door."

And lose my gun? Not a chance. I push the sleeve up over my left elbow, leaving my right hand free. "Will this work?"

"Not perfectly," Cantwell says. "But we'll find a way to make do."

Cantwell is irritated. Good. I want to keep him off his game, make him break his routine, so he doesn't see me coming after him. He ties a rubber tube around my left arm and taps the vein in the crook of my elbow with a latex-covered finger, then swabs it with alcohol.

"Make a fist, like you want to punch me," he says.

"Does anyone ever punch you?"

"Not since my residency."

"So you went to med school, huh?"

"First in my class," Cantwell says as he rips open a sterile package for a butterfly needle. "I was doing research at a university medical center when I created the viral therapy for the empathy genes."

"Why were you researching that?" I don't give a shit about his history, but I hate needles so it gives me something else to focus on.

"Idealism. I wanted to find a cure for sociopaths. Take all those men in prison and

make them safe for society. I thought that if I could activate their empathy genes, I could cure them. But it didn't work. This part only hurts a little."

The sharp pinch of the needle makes me wince.

"You can open your fist now." Cantwell smooths a piece of surgical tape over the catheter tubing, and then another. "Just having the genes isn't enough. It turns out that empathy also takes practice. Reading fiction helps, for example, but most of the men in prison are illiterate. Do you read books?"

"Don't really have time."

"Lots of executives don't." He dumps the extra supplies into a red box. "Because the therapy didn't work, we couldn't get funding. And then my research partner suggested that the real money was to be found in the opposite direction—"

"Let me see that."

I hold out my hand for the bag of IV fluid that Cantwell has just picked up. He hesitates, then gives it to me.

I read it carefully. The label has my name on it, followed by a list. I recognize "oxytocin A/A" and "vasopressin AVPR1a" and the others. The amount is 750ml, just like a bottle of wine.

"Do you have questions?" Cantwell says. "This item here is the location of your oxytocin receptors—"

"Go ahead." I hand it back. The bag looks right enough, I suppose. I still have my insurance. The moment I sense something wrong, I'll rip out the IV and put down the doctor.

Cantwell hangs the bag and connects it to the tubing. "It'll take a few minutes before you feel the effects."

A welcome cold chill rushes through my blood, like a thrill of victory. I'm really doing this. I'll be an unstoppable monster. I am going to take whatever I want, from whoever I want, and I am going to end up so rich.

"You were talking about the money," I say. "With the vaccine."

Cantwell pulls up a chair and sits across from me. "My partner said that there was no money treating monsters in the prisons, but there was plenty if we could help the monsters in the boardrooms. There is very little difference between sociopaths and psychopaths,

and most of that is due to environmental factors. Psychopaths make great CEOs. Many politicians are psychopaths. The fact is that psychopaths are running our country already.”

I snort. “Running it into the ground.”

“That was the point I tried to make. The great social inequity created by our business leaders and politicians perpetuates the environment that exacerbates sociopathy in the economically marginalized.”

I have a hard time following that sentence. Maybe the treatment is getting to me. “What?”

“But my partner didn’t listen. He found investors at a pharmaceutical company. The people who wouldn’t fund my work to give empathy to prisoners were eager to underwrite the exact same research to take empathy away from business executives. He was talking hundreds of millions of dollars.”

Money always talks. “And that’s when you listened to him.”

“Not at first. I thought it was a perfect example of everything that’s wrong in our society. I wasn’t interested in the money—I just wanted to make a positive difference.”

What a sucker. “Why not make a positive difference for yourself? Think of all the good you could do with that money.” My limbs tingle. Pins and needles. I wouldn’t call it painful yet, but I’m braced for the worst.

“That’s exactly what my partner said. I felt trapped, without any good options. If I did the research the way I wanted, it was a dead end, with no funding. If I took the pharmacy company’s money, it would only make the social problems worse.”

“So what did you do?” I ask just to hurry up his story. I know what I would have done.

“I gave myself the gene therapy.”

I’m surprised. “That sounds . . . smart.”

“It was great.” Enthusiasm leaks from Cantwell’s usually controlled voice, almost like he is bragging. Some guys just have to have an audience. “It gave me a clarity that I never had before. For the first time in my life, I felt like I had the freedom to do anything. And I finally saw a way I could make a real difference. I realized that I could cut the pharmaceutical companies completely out of the loop. That’s when I got rid of my partner and stole all the research so no else could copy it.”

“Audacious.” My head lolls to one side and my words are slurred. “Hey, I thought you said the vaccine hurt.”

“It’s not a vaccine,” he snaps. “And it does hurt—hours of sharp, body-wracking pain, nausea, and headache, followed by days of fever and weeks of being sick. It was the worst month of my life.” He moves his hand in an arc, like a street magician using misdirection, and points at the IV bag.

I follow the gesture and stare at the bag, confused. “But I don’t feel anything.” I hear a pair of soft clicks.

Cold metal clamps both my wrists. I look down.

Handcuffs.

Locking me to the arms of the chair.

“It doesn’t hurt because I’m not giving you the gene therapy,” Cantwell says. “This is hydromorphone, a narcotic. You’ll slowly fall asleep and then never wake up. It won’t hurt at all.”

I rattle the handcuffs, trying to reach my jacket pocket, but my arms feel so heavy. “You thieving son of a bitch.”

“You’re still awake because I want you to know that your money will go into a trust fund to help support the families and other victims of men like you. It will make a positive difference in the world.”

Fury surges through me like a rocket off a launchpad. Cantwell won’t get away with this. I try to tear out the IV with my teeth but I can’t quite reach it. I brace my legs to jump—one perfect lunge and I can tackle Cantwell. A scream tears out of my lips and I kick harder than I have ever kicked in his life.

The chair tips over.

My skull smacks the floor, setting off fireworks around my head. The checks spill out of one pocket while my gun bounces out of the other. Cantwell taps it leisurely with his paper-covered shoe. It skitters across the linoleum, out of reach. He picks up my checks.

I thrash against the restraints. “You’re supposed to give me the vaccine!”

“I never give anyone the vaccine.” Cantwell opens the stopcock, and darkness floods into my veins. His voice is faint and far away. “I may lack empathy, but I’m not a monster.” ■

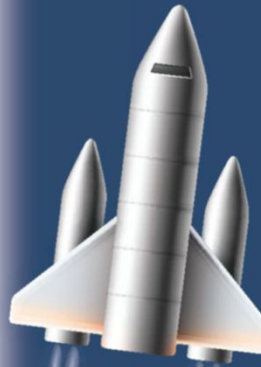
Flight

for Dennis and Diane

"Forty five miles an hour," Dennis shouted back
As his red and white pure-polished monster
Settled deep and surged due North
Away from L'Anse. We had planned to fish
The Big Lake, but despite marking many at depths
Down several hundred feet, we only caught
The wind and sun.

I thought of Henry Ford, Pequaming,
The loved machines of last century and Neil
Armstrong that boy from Ohio who could fly
Anywhere and, finally, set his polished
Model T of a spacecraft gently down
On the Moon. The sea is full of fish
That can wait another day. We caught the spirit:
truly blended minds and motors,
discovery and ancient finds.

—Mack Hassler



Three Bodies at Mitanni

Seth Dickinson

We were prepared to end the worlds we found. We were prepared to hurt each other to do it.

I thought Jotunheim would be the nadir, the worst of all possible worlds, the closest we ever came to giving the kill order. I thought that Anyahera's plea, and her silent solitary pain when we voted against her, two to one, would be the closest we ever came to losing her—a zero-sum choice between her conviction and the rules of our mission:

Locate the seedship colonies, the frozen progeny scattered by a younger and more desperate Earth. Study these new humanities. And in the most extreme situations: *remove existential threats to mankind.*

Jotunheim was a horror written in silicon and plasmid, a doomed atrocity. But it would never survive to be an existential threat to humanity. *I'm sorry, I told Anyahera. It would be a mercy. I know. I want to end it too. But it is not our place—*

She turned away from me, and I remember thinking: it will never be worse than this. We will never come closer.

And then we found Mitanni.

Lachesis woke us from stable storage as we fell toward periapsis. The ship had a mind of her own, architecturally human but synthetic in derivation, wise and compassionate and

beautiful but, in the end, limited to merely operational thoughts.

She had not come so far (five worlds, five separate stars) so very fast (four hundred years of flight) by wasting mass on the organic. We left our flesh at home and rode *Lachesis'* doped metallic hydrogen mainframe starward. She dreamed the three of us, Anyahera and Thienne and I, nested in the ranges of her mind. And in containing us, I think she knew us, as much as her architecture permitted.

When she pulled me up from storage, I thought she was Anyahera, a wraith of motion and appetite, flame and butter, and I reached for her, thinking she had asked to rouse me, as conciliation.

"We're here, Shinobu," *Lachesis* said, taking my hand. "The last seedship colony. Mitanni."

The pang of hurt and disappointment I felt was not an omen. "The ship?" I asked, by ritual. If we had a captain, it was me. "Any trouble during the flight?"

"I'm fine," *Lachesis* said. She filled the empty metaphor around me with bamboo panels and rice paper, the whispered suggestion of warm spring rain. Reached down to help me out of my hammock. "But something's wrong with this one."

I found my slippers. "Wrong how?"

"Not like Jotunheim. Not like anything we've seen on the previous colonies." She

offered me a robe, bowing fractionally. "The other two are waiting."

We gathered in a common space to review what we knew. Thienne smiled up from her couch, her skin and face and build all dark and precise as I remembered them from Lagos and the flesh. No volatility to Thienne; no care for the wild or theatrical. Just careful, purposeful action, like the machines and technologies she specialized in.

And a glint of something in her smile, in the speed with which she looked back to her work. She'd found some new gristle to work at, some enigma that rewarded obsession.

She'd voted against Anyahera's kill request back at Jotunheim, but of course Anyahera had forgiven her. They had always been opposites, always known and loved the certainty of the space between them. It kept them safe from each other, gave room to retreat and advance.

In the vote at Jotunheim, I'd been the contested ground between them. I'd voted with Thienne: *no kill*.

"Welcome back, Shinobu," Anyahera said. She wore a severely cut suit, double-breasted, fit for cold and business. It might have been something from her mother's Moscow wardrobe. Her mother had hated me.

Subjectively, I'd seen her less than an hour ago, but the power of her presence struck me with the charge of decades. I lifted a hand, suddenly unsure what to say. I'd known and loved her for years. At Jotunheim I had seen parts of her I had never loved or known at all.

She considered me, eyes distant, icy. Her father was Maori, her mother Russian. She was only herself, but she had her mother's eyes and her mother's way of using them in anger. "You look . . . indecisive."

I wondered if she meant my robe or my body, as severe and androgynous as the cut of her suit. It was an angry thing to say, an ugly thing, beneath her. It carried the suggestion that I was unfinished. She knew how much that hurt.

I'd wounded her at Jotunheim. Now she reached for the weapons she had left.

"I've decided on this," I said, meaning my body, hoping to disengage. But the pain of it made me offer something, conciliatory: "Would you like me some other way?"

"Whatever you prefer. Take your time about it." She made a notation on some invisible

piece of work, a violent slash. "Wouldn't want to do anything hasty."

I almost lashed out.

Thienne glanced at me, then back to her work: an instant of apology, or warning, or reproach. "Let's start," she said. "We have a lot to cover."

I took my couch, the third point of the triangle. Anyahera looked up again. Her eyes didn't go to Thienne, and so I knew, even before she spoke, that this was something they had already argued over.

"The colony on Mitanni is a Duong-Watts malignant," she said. "We have to destroy it."

I knew what a Duong-Watts malignant was because "Duong-Watts malignant" was a punch line, a joke, a class of human civilization that we had all gamed out in training. An edge case so theoretically improbable it might as well be irrelevant. Duong Phireak's predictions of a universe overrun by his namesake had not, so far, panned out.

Jotunheim was not far enough behind us, and I was not strong enough a person, to do anything but push back. "I don't think you can know that yet," I said. "I don't think we have enough—"

"Ship," Anyahera said. "Show them."

Lachesis told me everything she knew, all she'd gleaned from her decades-long fall toward Mitanni, eavesdropping on the telemetry of the seedship that had brought humanity here, the radio buzz of the growing civilization, the reports of the probes she'd fired ahead.

I saw the seedship's arrival on what should have been a garden world, a nursery for the progeny of her vat wombs. I saw catastrophe: a barren, radioactive hell, climate erratic, oceans poisoned, atmosphere boiling into space. I watched the ship struggle and fail to make a safe place for its children, until, in the end, it gambled on an act of cruel, desperate hope: fertilizing its crew, raising them to adolescence, releasing them on the world to build something out of its own cannibalized body.

I saw them succeed.

Habitation domes blistering the weathered volcanic flats. Webs of tidal power stations. Thermal boreholes like suppurating wounds in the crust. Thousands of fission reactors, beating hearts of uranium and molten salt—

Too well. Too fast. In seven hundred years of struggle on a hostile, barren world, their

womb-bred population exploded up toward the billions. Their civilization webbed the globe.

It was a boom unmatched in human history, unmatched on the other seedship colonies we had discovered. No Eden world had grown so fast.

"Interesting," I said, watching Mitanni's projected population, industrial output, estimated technological self-catalysis, all exploding toward some undreamt-of ceiling. "I agree that this could be suggestive of a Duong-Watts scenario."

It wasn't enough, of course. Duong-Watts malignancy was a disease of civilizations, but the statistics could offer only symptoms. That was the terror of it: the depth of the cause. The simplicity.

"Look at what *Lachesis* has found." Anyahera rose, took an insistent step forward. "Look at the way they live."

I spoke more wearily than I should have. "This is going to be another Jotunheim, isn't it?"

Her face hardened. "No. It isn't."

I didn't let her see that I understood, that the words *Duong-Watts malignancy* had already made me think of the relativistic weapons *Lachesis* carried, and the vote we would need to use them. I didn't want her to know how angry it made me that we had to go through this again.

One more time before we could go home. One more hard decision.

Thienne kept her personal space too cold for me: frosted glass and carbon composite, glazed constellations of data and analysis, a transparent wall opened onto false-color nebulae and barred galactic jets. At the low end of hearing, distant voices whispered in clipped aerospace phrasing. She had come from Haiti and from New Delhi, but no trace of that twin childhood, so rich with history, had survived her journey here.

It took me years to understand that she didn't mean it as insulation. The cold distances were the things that moved her, clenched her throat, pimpled her skin with awe. Anyahera teased her for it, because Anyahera was a historian and a master of the human, and what awed Thienne was to glimpse her own human insignificance.

"Is it a Duong-Watts malignant?" I asked her. "Do you think Anyahera's right?"

"Forget that," she said, shaking her head. "No prejudgment. Just look at what they've built."

She walked me through what had happened to humanity on Mitanni.

At Lagos U, before the launch, we'd gamed out scenarios for what we called *socially impoverished worlds*—places where a resource crisis had limited the physical and mental capital available for art and culture. Thienne had expected demand for culture to collapse along with supply as people focused on the necessities of existence. Anyahera had argued for an inelastic model, a fundamental need embedded in human consciousness.

There was no culture on Mitanni. No art. No social behavior beyond functional interaction in the service of industry or science.

It was an incredible divergence. Every seedship had carried Earth's cultural norms—the consensus ideology of a liberal democratic state. Mitanni's colonists should have inherited those norms.

Mitanni's colonists expressed no interest in those norms. There was no oppression. No sign of unrest or discontent. No government or judicial system at all, no corporations or markets. Just an array of specialized functions to which workers assigned themselves, their numbers fed by batteries of synthetic wombs.

There was no entertainment, no play, no sex. No social performance of gender. No family units. Biological sex had been flattened into a population of sterile females, slender and lightly muscled. "No sense wasting calories on physical strength with exoskeletons available," Thienne explained. "It's a resource conservation strategy."

"You can't build a society like this using ordinary humans," I said. "It wouldn't be stable. Free riders would play havoc."

Thienne nodded. "They've been rewired. I think it started with the first generation out of the seedship. They made themselves selfless so that they could survive."

It struck me that when the civilization on Mitanni built their own seedships they would be able to do this again. If they could endure Mitanni, they could endure anything.

They could have the galaxy.

I was not someone who rushed to judgment. They'd told me that, during the final round of

crew selection. *Deliberative. Centered. Disconnected from internal affect. High emotional latency. Suited for tiebreaker role....*

I swept the imagery shut between my hands, compressing it into a point of light. Looked up at Thienne with a face that must have signaled loathing or revulsion, because she lifted her chin in warning. "Don't," she said. "Don't leap to conclusions."

"I'm not."

"You're thinking about ant hives. I can see it."

"Is that a bad analogy?"

"Yes!" Passion, surfacing and subsiding. "Ant hives only function because each individual derives a fitness benefit, even if they sacrifice themselves. It's kin selective eusociality. This is—"

"Total, selfless devotion to the state?"

"To survival." She lifted a mosaic of images from the air: a smiling woman driving a needle into her thigh. A gang of laborers running into a fire, heedless of their own safety, to rescue vital equipment. "They're born. They learn. They specialize, they work, sleep, eat, and eventually they volunteer to die. It's the *opposite* of an insect hive. They don't cooperate for their own individual benefit—they don't seem to care about themselves at all. It's pure altruism. Cognitive, not instinctive. They're brilliant, and they all come to the same conclusion: cooperation and sacrifice."

The image of the smiling woman with the needle did not leave me when the shifting mosaic carried her away. "Do you admire that?"

"It's a society that could never evolve on its own. It has to be designed." She stared into the passing images with an intensity I'd rarely seen outside of deep study or moments of love, a ferocious need to master some vexing, elusive truth. "I want to know how they did it. How do they disable social behavior without losing theory of mind? How can they remove all culture and sex and still motivate?"

"We saw plenty of ways to motivate on Jotunheim," I said.

Maybe I was thinking of Anyahera, taking her stance by some guilty reflex, because there was nothing about my tone *disconnected from internal affect*.

I expected anger. Thienne surprised me. She swept the air clear of her work, came to

the couch and sat beside me. Her eyes were gentle.

"I'm sorry we have to do this again," she said. "Anyahera will forgive you."

"Twice in a row? She thought Jotunheim was the greatest atrocity in human history. 'A crime beyond forgiveness or repair,' remember? And I let it stand. I walked away."

I took Thienne's shoulder, gripped the swell of her deltoid, the strength that had caught Anyahera's eye two decades ago. Two decades for us—on Earth, centuries now.

Thienne stroked my cheek. "You only had two options. Walk away, or burn it all. You knew you weren't qualified to judge an entire world."

"But that's why we're here. To judge. To find out whether the price of survival ever became too high—whether what survived wasn't human."

She leaned in and kissed me softly. "Mankind changes," she said. "This—what you are—" Her hands touched my face, my chest. "People used to think this was wrong. There were men, and women, and nothing else, nothing more or different."

I caught her wrists. "That's not the same, Thienne."

"I'm just saying: technology changes things. We change *ourselves*. If everyone had judged what you are as harshly as Anyahera judged Jotunheim—"

I tightened my grip. She took a breath, perhaps reading my anger as play, and that made it worse. "Jotunheim's people are slaves," I said. "I can be what I want. It's not the same at all."

"No. Of course not." She lowered her eyes. "You're right. That was an awful example. I'm sorry."

"Why would you say that?" I pressed. Thienne closed herself, keeping her pains and fears within. Sometimes it took a knife to get them out. "Technology doesn't always enable the *right* things. If some people had their way I would be impossible. They would have found everything but man and woman and wiped it out."

She looked past me, to the window and the virtual starscape beyond. "We've come so far out," she said. I felt her shoulders tense, bracing an invisible weight. "And there's nothing out here. Nobody to meet us except our own seedship children. We thought we'd find someone else—at least some machine or memorial, some sign of other life. But after all this time

the galaxy is still a desert. If we screw up, if we die out . . . what if there's no one else to try?

"If whatever happened on Mitanni is what it takes to survive in the long run, isn't that better than a dead cosmos?"

I didn't know what to say to that. It made me feel suddenly and terribly alone. The way Anyahera might have felt, when we voted against her.

I kissed her. She took the distraction, answered it, turned us both away from the window and down onto the couch. "Tell me what to be," I said, wanting to offer her something, to make a part of the Universe warm for her. This was my choice: to choose.

"Just you—" she began.

But I silenced her. "Tell me. I want to."

"A woman," she said, when she had breath.

"A woman this time, please . . ."

Afterward, she spoke into the silence and the warmth, her voice absent, wondering: "They trusted the three of us to last. They thought we were the best crew for the job." She made absent knots with my hair. "Does that ever make you wonder?"

"The two-body problem has been completely solved," I said. "But for $n=3$, solutions exist for special cases."

She laughed and pulled me closer. "You've got to go talk to Anyahera," she said. "She never stays mad at me. But you . . ."

She trailed off, into contentment, or back into contemplation of distant, massive things.

Duong-Watts malignant, I thought to myself. I couldn't help it: my mind went back to the world ahead of us, closing at relativistic speeds.

Mitanni's explosive growth matched the theory of a Duong-Watts malignant. But that was just correlation. The malignancy went deeper than social trends, down to the individual, into the mechanisms of the mind.

And that was Anyahera's domain.

"We can't destroy them," Thienne murmured. "We might need them."

Even in simulation we had to sleep. *Lachesis*' topological braid computer could run the human being in full-body cellular resolution, clock us up to two subjective days a minute in an emergency, pause us for centuries—but not obviate the need for rest.

It didn't take more than an overclocked instant. But it was enough for me to dream.

Or maybe it wasn't my dream—just Duong Phireak's nightmare reappropriated. I'd seen him lecture at Lagos, an instance of his self transmitted over for the night. But this time he spoke in Anyahera's voice as she walked before me, down a blood-spattered street beneath a sky filled with alien stars.

"Cognition enables an arsenal of survival strategies inaccessible to simple evolutionary selection," she said, the words of Duong Phireak. "Foresight, planning, abstract reasoning, technological development—we can confidently say that these strategies are strictly superior, on a computational level, at maximizing individual fitness. Cognition enables the cognitive to pursue global, rather than local, goals. A population of flatworms can't cooperate to build a rocket unless the 'build a rocket' allele promotes individual fitness in each generation—an unlikely outcome, given the state of flatworm engineering."

Memory of laughter, compressed by the bandwidth of the hippocampus. I reached out for Anyahera, and she looked up and only then, following her gaze, did I recognize the sky, the aurora of Jotunheim.

"But with cognition came consciousness—an exaptive accident, the byproduct of circuits in the brain that powered social reasoning, sensory integration, simulation theaters, and a host of other global functions. So much of our civilization derived in turn from consciousness, from the ability not just to enjoy an experience but to *know* that we enjoy it. Consciousness fostered a suite of behaviors without clear adaptive function, but with subjective, experiential value."

I touched Anyahera's shoulder. She turned toward me. On the slope of her bald brow glittered the circuitry of a Jotunheim slave shunt, bridging her pleasure centers into her social program.

Of course she was smiling.

"Consciousness is expensive," she said. "This is a problem for totalitarian states. A human being with interest in leisure, art, agency—a human being who is *aware* of her own self-interest—cannot be worked to maximum potential. I speak of more than simple slave labor. I am sure that many of your professors wish you could devote yourselves more completely to your studies."

Overhead, the aurora laughed in the voices of Lagos undergraduates, and when I looked

up, the sky split open along a dozen fiery fractures, relativistic warheads moving in ludicrous slow-motion, burning their skins away as they made their last descent. *Lachesis*' judgment. The end I'd withheld.

"Consciousness creates inefficient behavior," Anyahera said, her smile broad, her golden-brown skin aflame with the light of the falling apocalypse. "A techno-tyranny might take the crude step of creating slave castes who derive conscious pleasure from their functions, but this system is fundamentally inadequate, unstable. The slave still expends caloric and behavioral resources on *being conscious*; the slave seeks to maximize its own pleasure, not its social utility. A clever state will go one step further and eliminate the cause of these inefficiencies at the root. They will sever thought from awareness."

"This is what I call the Duong-Watts malignancy. The most efficient, survivable form of human civilization is a civilization of philosophical zombies. A nation of the unconscious, those who think without knowing they exist, who work with the brilliance of our finest without ever needing to ask *why*. Their cognitive abilities are unimpaired—enhanced, if anything—without constant interference. I see your skepticism; I ask you to consider the anosognosia literature, the disturbing information we have assembled on the architecture of the sociopathic mind, the vast body of evidence behind the deflationary position on the Hard Problem.

"We are already passengers on the ship of self. It is only a matter of time until some designer, pressed for time and resources, decides to jettison the hitchhiker. And the rewards will be enormous—in a strictly Darwinian sense."

When I reached for her, I think I wanted to shield her, somehow, to put myself between her and the weapons. It was reflex, and I knew it was meaningless, but still . . .

Usually in dreams you wake when you die. But I felt myself come apart.

Ten light-hours out from Mitanni's star, falling through empty realms of ice and hydrogen, we slammed into a wall of light—the strobe of a lighthouse beacon orbiting Mitanni. "Pulse-compressed burst maser," *Lachesis* told me, her voice clipped as she dissected the signal. "A fusion-pumped flashbulb."

Lachesis' forward shield reflected light like a wall of diamond—back toward the star, toward Mitanni. In ten hours they would see us.

We argued over what to do. Anyahera wanted to launch our relativistic kill vehicles now, so they'd strike Mitanni just minutes after the light of our approach, before the colonists could prepare any response. Thienne, of course, dissented. "Those weapons were meant to be used when we were certain! Only then!"

I voted with Thienne. I knew the capabilities of our doomsday payload with the surety of reflex. We had the safety of immense speed, and nothing the Mitanni could do, no matter how sophisticated, could stop our weapons—or us. We could afford to wait, and mull over our strategy.

After the vote, Anyahera brushed invisible lint from the arm of her couch. "Nervous?" I asked, probing where I probably shouldn't have. We still hadn't spoken in private.

She quirked her lips sardonically. "Procrastination," she said, "makes me anxious."

"You're leaping to conclusions," Thienne insisted, pacing the perimeter of the command commons. Her eyes were cast outward, into the blue-shifted stars off our bow. "We can't know it's a Duong-Watts malignant. Statistical correlation isn't enough. We have to be sure. We have to understand the exact mechanism."

It wasn't the same argument she'd made to me.

"We don't need to be sure." Anyahera had finished with the invisible lint. "If there's any reasonable chance this is a Duong-Watts, we are morally and strategically obligated to wipe them out. This is *why we are here*. It doesn't matter how they did it—if they did it, they have to go."

"Maybe we need to talk to them," I said.

They both stared at me. I was the first one to laugh. We all felt the absurdity there, in the idea that we could, in a single conversation, achieve what millennia of philosophy had never managed—find some way to pin down the spark of consciousness by mere dialogue. Qualia existed in the first person.

But twenty hours later—nearly three days at the pace of *Lachesis*' racing simulation clock—that was suddenly no longer an abstract problem. Mitanni's light found us again: not a blind, questing pulse, but a microwave needle, a long clattering encryption of something at once unimaginably intricate and completely familiar.

They didn't waste time with prime numbers or queries of intent and origin. Mitanni sent us an uploaded mind, a digital ambassador.

Even Thienne agreed it would be hopelessly naïve to accept the gift at face value, but after *Lachesis* dissected the upload, ran its copies in a million solipsistic sandboxes, tested it for every conceivable virulence—we voted unanimously to speak with it, and see what it had to say.

Voting with Anyahera felt good. And after we voted, she started from her chair, arms upraised, eyes alight. "They've given us the proof," she said. "We can—Thienne, Shinobu, do you see?"

Thienne lifted a hand to spider her fingers against an invisible pane. "You're right," she said, lips pursed. "We *can*."

With access to an uploaded personality, the digital fact of a Mitanni brain, we could compare their minds to ours. It would be far from a simple arithmetic hunt for subtraction or addition, but it would give us an empirical angle on the Duong-Watts problem.

Anyahera took me aside, in a space as old as our friendship, the khaya mahogany panels and airy glass of our undergraduate dorm. "Shinobu," she said. She fidgeted as she spoke, I think to jam her own desire to reach for me. "Have you seen what they're building in orbit?"

This memory she'd raised around us predated Thienne by a decade. That didn't escape me.

"I've seen them," I said. I'd gone through Mitanni's starflight capabilities datum by datum. "Orbital foundries. For their own seedships. They're getting ready to colonize other stars."

Neither of us had to unpack the implications there. It was the beginning of a boom cycle—exponential growth.

"Ten million years," she said. "I've run a hundred simulations out that far. If Mitanni is a Duong-Watts, in ten million years the galaxy is full of them. Now and forever. No conscious human variant can compete. Not even digitized baseline humans—you know what it took just to make *Lachesis*. Nothing human compares."

I nodded in silent acknowledgment. *Is that so terrible?* I wanted to ask—Thienne's question, in this memory so empty of her. *Is consciousness what we have to sacrifice to survive in the long run?*

She didn't even need me to ask the question. "I can envision nothing more monstrous," she said, "than mankind made clockwork. Nothing is worth that price."

And I wanted to nod, just to show her that we were not enemies. But I couldn't. It felt like giving in.

Sometimes I wondered at the hubris of our mission. Would Mitanni live and die not by the judgment of a jurisprudent mind but the troubled whims of a disintegrating family? We had left Earth as a harmonized unit, best-in-class product of a post-military, post-national edifice that understood the pressures of long-duration, high-stress starflight. No one and nothing could judge better. But was that enough? Was the human maximum adequate for this task?

Something in that thought chilled me more than the rest, and I wished I could know precisely what.

We met the Mitanni upload in a chameleon world: a sandboxed pocket of *Lachesis*' mind, programmed to cycle from ocean to desert to crowd to solitary wasteland, so that we could watch the Mitanni's reactions, and, perhaps, come to know her.

She came among us without image or analogy, injected between one tick of simulation and the next. We stood around her on a pane of glass high above a grey-green sea.

"Hello," she said. She smiled, and it was not at all inhuman. She had Thienne's color and a round, guileless face that with her slight build made me think of Jizo statues from my childhood. "I'm the ambassador for Mitanni."

Whatever language she spoke, *Lachesis* had no trouble with it. Thienne and Anyahera looked to me, and I spoke as we'd agreed.

"Hello. My name is Shinobu. This is the starship *Lachesis*, scout element of the Second Fleet."

If she saw through the bluff of scouts and fleets, she gave no sign. "We expected you," she said, calm at the axis of our triplicate regard. "We detected the weapons you carry. Because you haven't fired yet, we know you're still debating whether to use them. I am here to plead for our survival."

She's rationally defensive, Thienne wrote in our collective awareness. *Attacking the scenario of maximal threat.*

At the edge of awareness, *Lachesis*' telemetry whispered telltales of cognition and feedback, a map of the Mitanni's thoughts. Profiling.

My eyes went to Anyahera. We'd agreed she would handle this contingency. "We believe your world may be a Duong-Watts malignant," she said. "If you've adapted yourselves to survive by eliminating consciousness, we're deeply concerned about the competitive edge you've gained over baseline humanity. We believe consciousness is an essential part of human existence."

In a negotiation between humans, I think we would have taken hours to reach this point, and hours more to work through the layers of bluff and counter-bluff required to hit the next point. The Mitanni ambassador leapt all that in an instant. "I'm an accurate map of the Mitanni mind," she said. "You have the information you need to judge the Duong-Watts case."

I see significant mental reprofiling, Lachesis printed. Systemic alteration of networks in the thalamic intralaminar nuclei and the prefrontal-parietal associative loop. Hyperactivation in the neural correlates of rationalization—

Anyahera snapped her fingers. The simulation froze, the Mitanni ambassador caught in the closing phoneme of her final word. "That's it," Anyahera said, looking between the two of us. "Duong-Watts. That's your smoking gun."

Even Thienne looked shocked. I saw her mouth the words: *hyperactivation in the neural—*

The Mitanni hadn't stripped their minds of consciousness. They'd just locked it away in a back room, where it could watch the rest of the brain make its decisions, and cheerfully, blithely, blindly consider itself responsible.

—correlates of rationalization—

Some part of the Mitanni mind knew of its own existence. And that tiny segment watched the programming that really ran the show iterate itself, feeling every stab of pain, suffering through every grueling shift, every solitary instant of a life absent joy or reward. Thinking: *this is all right. This is for a reason. This is what I want. Everything is fine.* When hurt, or sick, or halfway through unanaesthetized field surgery, or when she drove the euthanasia needle into her thigh: *this is what I want.*

Because they'd tweaked some circuit to say: *you're in charge. You are choosing this.* They'd wired in the perfect lie. Convinced the last domino that it was the first.

And with consciousness out of the way, happy to comply with any sacrifice, any

agony, the program of pure survival could optimize itself.

"It's parsimonious," Thienne said at last. "Easier than stripping out all the circuitry of consciousness, disentangling it from cognition..."

"This is Duong-Watts," Anyahera said. I flinched at her tone: familiar only from memories of real hurt and pain. "This is humanity enslaved at the most fundamental level."

I avoided Thienne's glance. I didn't want her to see my visceral agreement with Anyahera. Imagining that solitary bubble of consciousness, lashed, parasitic, to the bottom of the brain, powerless and babbling.

To think that you could change yourself. To be wrong, and never know it. That was a special horror.

Of course Thienne saw anyway, and leapt in, trying to preempt Anyahera, or my own thoughts. "This is not the place to wash your hands of Jotunheim. There's no suffering here. No crime to erase. All they want to do is survive—"

"Survival is the question," Anyahera said, turned half away, pretending disregard for me, for my choice, and in that disregard signaling more fear than she had begging on her knees at Jotunheim, because Anyahera would only ever disregard that which she thought she had no hope of persuading. "The survival of consciousness in the galaxy. The future of cognition. We decide it right here. We fire or we don't."

Between us the Mitanni stood frozen placidly, mid-gesture.

"Kill the Mitanni," Thienne said, "and you risk the survival of *anything at all.*"

It hurt so much to see both sides. It always had.

Three-player variants are the hardest to design.

Chess. Shogi. Nuclear detente. War. Love. Galactic survival. Three-player variants are unstable. It was written in my first game theory text: *Inevitably, two players gang up against a third, creating an irrecoverable tactical asymmetry.*

"You're right, Thienne," I said. "The Mitanni aren't an immediate threat to human survival. We're going home."

We fell home to Earth, to the empty teak house, and when I felt Anyahera's eyes upon me I knew myself measured a monster, an accomplice to extinction. Anyahera left, and

with her gone, Thienne whirled away into distant dry places far from me. The Mitanni bloomed down the Orion Arm and leapt the darkness between stars.

"Anyahera's right," I said. "The Mitanni will overrun the galaxy. We need to take a stand for—for what we are. Fire the weapons."

We fell home to Earth and peach tea under the Lagos sun, and Thienne looked up into that sun and saw an empty universe. Looked down and saw the two people who had, against her will, snuffed out the spark that could have kindled all that void, filled it with metal and diligent labor: life, and nothing less or more.

I took a breath and pushed the contingencies away. "This isn't a zero-sum game," I said. "I think that other solutions exist. Joint outcomes we can't ignore."

They looked at me, their pivot, their battleground. I presented my case.

This was the only way I knew how to make it work. I don't know what I would have done if they hadn't agreed.

They chose us for this mission, us three, because we could work past the simple solutions.

The Mitanni ambassador stood between us as we fell down the thread of our own orbit, toward the moment of weapons release, the point of no return.

"We know that Mitanni society is built on the Duong-Watts malignancy," Anyahera said.

The Mitanni woman lifted her chin. "The term *malignancy* implies a moral judgment," she said. "We're prepared to argue on moral grounds. As long as you subscribe to a system of liberal ethics, we believe that we can claim the right to exist."

"We have strategic concerns," Thienne said, from the other side of her. "If we grant you moral permit, we project you'll colonize most of the galaxy's habitable stars. Our own seedships or digitized human colonists can't compete. That outcome is strategically unacceptable."

We'd agreed on that.

"Insects outnumber humans in the terrestrial biosphere," the Mitanni said. I think she frowned, perhaps to signal displeasure at the entomological metaphor. I wondered how carefully she had been tuned to appeal to us. "An equilibrium exists. Coexistence that harms neither form of life."

"Insects don't occupy the same niche as humans," I said, giving voice to Anyahera's fears. "You do. And we both know that we're the largest threat to your survival. Sooner or later, your core imperative would force you to act."

The ambassador inclined her head. "If the survival payoff for war outstrips the survival payoff for peace, we will seek war. And we recognize that our strategic position becomes unassailable once we have launched our first colony ships. If it forestalls your attack, we are willing to disassemble our own colonization program and submit to a blockade—"

"No." Thienne again. I felt real pride. She'd argued for the blockade solution and now she'd coolly dissect it. "We don't have the strength to enforce a blockade before you can launch your ships. It won't work."

"We are at your mercy, then." The ambassador bowed her chin. "Consider the moral ramifications of this attack. Human history is full of attempted genocide, unilateral attempts to control change and confine diversity, or to remake the species in a narrow image. Full, in the end, of profound regret."

The barb struck home. I don't know by what pathways pain becomes empathy, but just then I wondered what her tiny slivered consciousness was thinking, while the rest of her mind thrashed away at the problem of survival: *The end of the world is coming, and it's all right; I won't worry, everything's under control—*

Anyahera took my shoulder in silence.

"Here are our terms," I said. "We will annihilate the Mitanni colony in order to prevent the explosive colonization of the Milky Way by post-conscious human variants. This point is non-negotiable."

The Mitanni ambassador waited in silence. Behind her, Thienne blinked, just once, an indecipherable punctuation. I felt Anyahera's grip tighten in gratitude or tension.

"You will remain in storage aboard the *Lachesis*," I said. "As a comprehensive upload of a Mitanni personality, you contain the neuroengineering necessary to recreate your species. We will return to Earth and submit the future of the Mitanni species to public review. You may be given a new seedship and a fresh start, perhaps under the supervision of a preestablished blockade. You may be consigned to archival study, or allowed to

flourish in a simulated environment. But we can offer a near-guarantee that you will not be killed."

It was a solution that bought time, delaying the Duong-Watts explosion for centuries, perhaps forever. It would allow us to study the Duong-Watts individual, to game out their survivability with confidence and the backing of a comprehensive social dialogue. If she agreed.

It never occurred to me that she would hesitate for even one instant. The core Mitanni imperative had to be *survive*, and total annihilation weighed against setback and judgment and possible renaissance would be no choice at all.

"I accept," the Mitanni ambassador said. "On behalf of my world and my people, I am grateful for your jurisprudence."

We all bowed our heads in unrehearsed mimicry of her gesture. I wondered if we were aping a synthetic mannerism, something they had gamed out to be palatable.

"*Lachesis*," Anyahera said. "Execute RKV strike on Mitanni."

"I need a vote," the ship said.

I think that the Mitanni must have been the only one who did not feel a frisson: the judgment of history, cast back upon us.

We would commit genocide here. The largest in human history. The three of us, who we were, what we were, would be chained to this forever.

"Go," I said. "Execute RKV strike."

Thienne looked between the two of us. I don't know what she wanted to see but I met her eyes and held them and hoped.

Anyahera took her shoulder. "I'm sorry," she said.

"Go," Thienne said. "Go."

We fell away from the ruin, into the void, the world that had been called Mitanni burning away the last tatters of its own atmosphere behind us. *Lachesis* clawed at the galaxy's magnetic field, turning for home.

"I wonder if they'll think we failed," Anyahera said drowsily. We sat together in a pavilion, the curtains drawn.

I considered the bottom of my glass. "Because we didn't choose? Because we compromised?"

She nodded, her hands cupped in her lap. "We couldn't go all the way. We brought our

problems home." Her knuckles whitened. "We made accommodations with something that—"

She looked to her left, where Thienne had been, before she went to be alone. After a moment she shrugged. "Sometimes I think this is what they wanted all along, you know. That we played into their hands."

I poured myself another drink: cask strength, unwatered. "It's an old idea," I said.

She arched an eyebrow.

"That we can't all go home winners." I thought of the pierced bleeding crust of that doomed world and almost choked on the word *winners*—but I knew that for the Mitanni, who considered only outcomes, only pragmatism, this was victory. "That the only real solutions lie at the extremes. That we can't figure out something wise if we play the long game, think it out, work every angle."

For $n=3$, solutions exist for special cases.

"Nobody won on Jotunheim," Anyahera said softly.

"No," I said. Remembered people drowning in acid, screaming their final ecstasy because they had been bred and built for pain. "But we did our jobs, when it was hardest. We did our jobs."

"I still can't sleep."

"I know." I drank.

"Do you? Really?"

"What?"

"I know the role they selected you for. I know *you*. Sometimes I think—" She pursed her lips. "I think you change yourself so well that there's nothing left to carry scars."

I swallowed. Waited a moment, to push away my anger, before I met her gaze. "Yeah," I said. "It hurt me too. We're all hurt."

A moment passed in silence. Anyahera stared down into her glass, turning it a little, so that her reflected face changed and bent.

"To new ideas," she said, a little toast that said with great economy everything I had hoped for, especially the apologies.

"To new ideas."

"Should we go and—?" She made a worried face and pointed to the ceiling, the sky, where Thienne would be racing the causality of her own hurt, exploring some distant angle of the microwave background, as far from home as she could make the simulation take her.

"Not just yet," I said. "In a little while. Not just yet." ■

The *Analog* Millennium

Mike Ashley

1,000 issues.

ONE THOUSAND ISSUES.

That's better. Since it began with its January 1930 issue, released at the start of December 1929, *Analog*—then called *Astounding Stories of Super Science*—has, to this June 2015 number, amassed one thousand issues. It's the first science-fiction magazine to do so, way ahead of any competition.

Let's clarify that total. I'm talking about each individual, physical issue. Today, *Analog* publishes ten issues a year, two of which are "double" issues, but I count each "double" issue as one. There have been thirty such issues since the first double for July/August 1997, but I doubt anyone would win the argument that this issue is therefore the 1,030th and that the thousandth was that for July/August 2012. When you look at the issues on the shelf, the double numbers still appear as one single issue.

For most of its life *Astounding/Analog* has appeared monthly. For some years, it appeared four-weekly, but there were a few gaps in its schedule in 1932/33, as well as ten rather than twelve a year today. Had the magazine

Maybe that trips too quickly off the tongue. Let me repeat it.

remained monthly since its first issue, it would have reached the thousandth month in April 2013. So we're just over two years late.

Any collector who has a complete run knows how much a thousand issues are. My run fills nearly eleven meters of shelving. I can't store them all in one place because, during its eighty-five years, *Astounding/Analog* (hereinafter simplified to *ASF*) has kept changing size, from pulp to letter-size, back to pulp, then digest, then semi-slick, and then various gradations of digest.

Looking back through those issues feels like you are witnessing not only the history and evolution of science fiction, but also many of the major events of the last century, much of which contributed to the mood and content of the stories themselves. The magazine was born in the days of the Wall Street Crash in October 1929, but in looking to the stars and to the future it provided both hope and light relief to many. The magazine was already ten years old and its 107th issue was on the newsstands when War was declared in Europe, pre-saging a global conflict that had already been predicted in many of its stories. Its 134th issue was on sale when the United States entered the War after the attack on Pearl Harbor. The

178th issue was on sale when the first atomic bombs were detonated over Japan in August 1945, ushering in the nuclear age, which had also been predicted in many of its stories. When Yuri Gagarin became the first man in space in April 1961 the 366th issue was on sale, and it was a hundred issues later when Neil Armstrong became the first man to walk on the Moon, and when the dreams of science fiction were finally vindicated.

I could go on, but that is enough to emphasize just how much *ASF* can be seen as both a forecaster and a reflection of the history of the last century.

But let's focus in on the magazine itself. We need to put these thousand issues into some perspective. I said it is the first SF magazine to achieve this total. In fact, it's been ahead of the game since July 1965 when it hit its 416th issue. Since then, no other SF magazine has kept up with it.

The first true SF magazine was *Amazing Stories*, with its first issue dated April 1926. *Weird Tales*, which ran a fair quota of SF, had appeared three years earlier in March 1923. *Weird Tales* made its first hundred issues in April 1932, *Amazing* in August 1934 and *Astounding* in March 1939. That order remained for the next hundred. *Weird Tales* made two hundred in July 1941, *Amazing* in December 1945 and *Astounding* in July 1947. But the gap was closing as *Astounding* was the only

one of those three to keep to a monthly schedule.

Weird Tales folded in September 1954 with its 279th issue.¹ *Amazing Stories* reached the three hundred mark in November 1955 and, by a remarkable coincidence, so did *Astounding*. That was the month when *Astounding* caught up. The two remained side by side until June 1965, the 415th issue for both of them. Then *Amazing* slipped to a bi-monthly schedule, and *Astounding*, which by October 1960 had changed its name to *Analog*, continued appearing month after month, racking up the totals: five hundredth issue in July 1972, six hundredth in November 1980, the seven hundredth in August 1988 and so on. No other print SF magazine, English-language or otherwise, has come close to matching this total. The nearest is *The Magazine of Fantasy & Science Fiction* which, this month, sees its 714th issue.

So first let's show how this total stands out against other English-language SF magazines. Table 1 shows all those SF magazines that have published two hundred or more print issues. It includes two related fantasy/weird-fiction magazines for comparison, but excludes comics, gaming, and media magazines. The chart relates only to print issues and does not include any issues only available online. It shows clearly how far *Analog* is ahead of its companions and rivals, past and present.

Table 1. Total print issues of English-language SF magazines as at June 2015.

Magazine	First issue	Last print issue	Total issues
<i>Astounding SF/Analog</i>	January 1930	current	1000
<i>Magazine of Fantasy & Science Fiction</i>	Fall 1949	current	714
<i>Amazing Stories</i>	April 1926	February 2005	608
<i>Asimov's Science Fiction</i>	Spring 1977	current	432
<i>Weird Tales</i> (including revivals)	March 1923	current	362
<i>Galaxy</i>	October 1950	March/April 1995	262
<i>Interzone</i>	Spring 1982	current	258
<i>New Worlds</i>	[Summer] 1946	September 1997	222
<i>Fantastic</i>	Summer 1952	October 1980	208
<i>Omni</i>	October 1978	Winter 1995	200

¹ *Weird Tales* has been revived several times since and eventually made three hundred issues in spring 1991. Since the time of writing it is believed issue #363 will have appeared.

Can it ever be overtaken? Certainly not by any current print magazines, either in the English language or elsewhere. The longest continuously published non-English language science-fiction magazine is Japan's *SF Magazine* from Hayakawa, which first appeared in February 1960. It has been published monthly ever since, with an occasional extra thirteenth issue. I believe its latest issue for June 2015 is its 711th, so that even if it continues to appear monthly, it will be a long time before it overtakes *Analog*.

It's a different matter with online magazines, however. These have grown substantially in the last twenty years and take on a variety of forms. Very few are comparable to a print format magazine, which is not surprising as it is a totally different medium. Some online magazines try and reproduce the standard approach by issuing a monthly (or quarterly or whenever) issue but most operate as a website, adding new material as and when available, sometimes daily. There are several weekly online magazines, some of which also upload items daily but then aggregate them as a formal weekly issue. One such is *Strange Horizons* (<http://www.strangehorizons.com/>), which has been running weekly since September 1, 2000. It usually misses the Christmas week and generally runs fifty-one issues a year, so it has already released 748 issues as at the start of May 2015. None of these issues is as substantial as an issue of *Analog*, consisting usually of one or two essays, a piece of fiction and several reviews and commentary. Each monthly set of issues would be closer to *Analog* in scale, and there would be 180 of those. But, if we accept each weekly upload as a genuine magazine issue, then *Strange Horizons* is rapidly gaining on *Analog* and would overtake sometime during 2021 if all factors remain the same.

A closer comparison would be *Bewildering Stories* (<http://www.bewilderingstories.com/>). This has been appearing weekly since July 2002 and each issue is a substantial offering, often with a complete or serialized novel, a novella or novelette and several short stories, poems and features. It usually skips a few vacation weeks such as Christmas and Easter and, since 2006, has averaged forty-seven issues a year. The first issue at the start of May 2015 will be 618. So if everything continues as

at present, *Bewildering Stories* will overtake *Analog* sometime in the fall of 2025.

However we look at it, *Analog's* remarkable total is safe amongst genre magazines for several years yet. But how well does it compare with other non-genre fiction magazines?

Over the centuries there have been plenty of long-running magazines. One of the first, the English *Gentleman's Magazine*, ran for 176 years (1731-1907) and 2,121 issues. For most of its run, though, it carried very little fiction. The more famous *Blackwood's Magazine* featured a lot of fiction, including some science fiction. It lasted for 163 years (1817-1980) and 1,982 issues. In the United States, *Harper's Magazine* has been appearing monthly since June 1850, so is approaching 166 years and will be celebrating its two thousandth issue at the end of next year. The granddaddy of them all, at least those publishing fiction, is *The Saturday Evening Post*. Although it likes to claim its origins as far back as 1728, the magazine really began in 1821 and was a weekly for most of its existence up until 1962 when it began to combine Christmas and then summer issues. When the magazine folded in 1969 it had seen 7,564 issues by my reckoning. Since its revival in 1971 it has seen a further 312, so it has a total of 7,876 issues.

But are we really comparing like with like? *SEP* was, after all, a weekly magazine featuring general fiction, articles and popular commentary. *Harper's* is a monthly magazine, but again one of general fiction and features. Neither are genre magazines and neither had their origins in the pulp fiction field.

It's worth considering how *Analog* compares amongst its brethren, the pulps and specialist genre titles. The first true pulp magazine, *The Argosy*, started out as *The Golden Argosy*, on December 9, 1882, a weekly for young readers, and saw 590 issues in that form before it turned monthly, on quality coated stock, in April 1894. It did not convert to pulp paper until December 1896. It remained as a pulp until August 1943, a run of 1,532 issues before it converted to a men's magazine. It continued until November 1979, another 415 issues. It has been revived twice, but only for short runs, the last ending as recently as Spring 2005. Its total existence saw 2,577 issues. However, we would need to drop the first 590 issues to compare

properly with *ASF*, which gives us 1,987 issues.

The first true specialist pulp was *Detective Story Magazine*, which began on October 5, 1915. It was published by Street & Smith and so, for part of its life, it was a companion to *Astounding*. This, and several other early genre pulps, grew out of various dime-novel series. *Detective Story Magazine* took over from *Nick Carter Stories* which itself dates back to the *Nick Carter Library* started in August 1891. However, for the purposes of

comparison, I am excluding dime novels or similar progenitors and am counting only pulp issues and successors either as men's magazines or digests. Table 2 shows all of *Astounding's* pulp rivals that existed at the time it first appeared and when they ceased. I have, though, included its current mystery-magazine companions, *Ellery Queen's* and *Alfred Hitchcock's* to make a complete picture. The totals include any revivals by other publishers.

Table 2. Longest running English-language pulp/digest magazines.

Magazine	First pulp/adult issue	Last or latest issue (at June 2015)	Total issues
<i>The Argosy</i>	April 1894	Spring 2005	1987
<i>Western Story Magazine</i>	September 5, 1919	June 1954	1289
<i>Love Story Magazine</i>	July 10, 1921	September 1954	1173
<i>Short Stories</i> (see Note 1)	June 1890	August 1959	1114
<i>Detective Story Magazine</i>	October 5, 1915	September 1953	1063
<i>Astounding SF/Analog</i>	January 1930	current	1000
<i>Flynn's/Detective Story Weekly</i>	September 20, 1924	July 1951	929
<i>Ranch Romances</i>	September 1924	November 1971	886
<i>Adventure</i>	November 1910	April 1971	878
<i>Ellery Queen's Mystery Magazine</i>	Fall 1941	current	845
<i>Wild West Weekly</i>	August 13, 1927	November 1943	824
<i>Blue Book Magazine</i>	May 1906	January 1975	722
<i>Magazine of Fantasy & Science Fiction</i>	Fall 1949	current	714
<i>Railroad Man's Magazine</i>	October 1906	January 1979	692
<i>Alfred Hitchcock's Mystery Magazine</i>	December 1956	current	689

Notes: (1) *Short Stories* began as a slim, smaller-than-pulp magazine consisting primarily of reprints from Europe. It did not become a pulp magazine until March 1910, switching to digest in July 1953, with its last three issues as a large format men's magazine, like *Argosy*. From March 1910 to the end, it saw 876 issues.

(2) This table covers only US magazines which published pulp or digest issues during its existence. In the United Kingdom, *Cassell's Magazine*, which began as a rather strict Victorian magazine in April 1867, gradually loosened its belt over the years and became an all-fiction pulp in April 1912, remaining so until it ceased in December 1932. Its total run was 789 issues.

The table shows that *ASF* has outlived all of its former competitors and is technically the last survivor of the pulps. *Railroad Man's Magazine* was revived in May 1979 as a railroad enthusiast's publication called *Railfan and Railroad* but no longer runs

any fiction and is really another magazine entirely. The last of the pulps to retain the pulp format was *Ranch Romances*. *ASF's* longevity, now in its 86th year, makes it second only to *Argosy* as the most resilient "pulp" title. In its original existence, from 1882 to 1979,

Argosy survived for 97 years, its two subsequent revivals adding nothing to this. Excluding the original weekly, *The Argosy* ceased in its 86th year, so *ASF* can also claim the honor of being the longest lived of the original pulp magazines.

Clearly, *ASF* is a survivor, and several further statistics may help us understand why and how it has survived. One challenge that can be thrown at any long-running magazine is how

consistent it has been over the years and true to its original values. One reason for *ASF*'s consistency is that over its thousand issues it has only had six editors, and two of them for record-breaking tenures. Table 3 lists the editors and issues for which they were responsible.

For the record, although Campbell was responsible for more issues than Schmidt, Schmidt was three months longer in post. Campbell was editor from October 5, 1937 to

Table 3. Number of issues edited by each successive editor.

Editor	First and last issues (as per issue dates not months employed)	Total issues
Harry Bates	January 1930 to March 1933	34
F. Orlin Tremaine	October 1933 to December 1937	51
John W. Campbell, Jr.	January 1938 to December 1971	408
Ben Bova	January 1972 to November 1978	83
Stanley Schmidt	December 1978 to March 2013	401
Trevor Quachri	succeeded April 2013	<i>23 and counting</i>

July 11, 1971, a period of 33 years, nine months, six days. Schmidt was appointed on September 1, 1978 and retired on August 31, 2012, making it a complete 34 years. No other SF editor has equalled this, the next longest being Edward Ferman at *F&SF*. Ferman took over the editorial reins formally from the January 1966 issue. His last issue as editor was June 1991, a run of 306 issues over 25 years and six months.²

This consistency and continuity has helped sustain *ASF* over the years, even when it could have ceased publication on at least three occasions. The first was when the original publisher of *Astounding Stories*, William M. Clayton, was forced into bankruptcy at the end of 1932 when he was unable to complete an agreed payment to his former partner. Clayton's magazines were auctioned off during 1933 and Street & Smith eventually acquired four of the titles, including *Astounding Stories*. It was not as if Street & Smith was

desperate to buy a science fiction magazine. Their interest was in the detective and western magazines, since they also acquired *Clues* and *Cowboy Stories*. *Astounding* came along in the package because it had good sales and a ready readership.

The editorial head of Clayton's company had been F. Orlin Tremaine, to whom editor Harry Bates reported, so Tremaine was already au fait with *Astounding*. In addition, Bates's assistant Desmond Hall also came across to Street & Smith. So whilst it might seem at first that there had been a clean break between the Clayton *Astounding* and Street & Smith's, there was a relatively stable transition.

Tremaine and Hall worked closely together, reestablishing *Astounding*, and building both its circulation and reputation. This held it in good stead, because in September 1937, Street & Smith undertook an efficiency review of all its magazines as part of a major

² Ferman effectively took over from the May 1965 issue, which makes his editorial total 314 issues. Ferman remained as publisher, with some editorial control, until January 2001, so he had a continued responsibility for the magazine for a further 105 issues, giving a total of 411 [or 419], but these 105 were not directly as editor.

shake-up. The publisher was looking to move into the slick-magazine market and phase out its pulps. It had already had a significant success with *Mademoiselle*, which began in February 1935 edited by none other than Desmond Hall. As a result, ten magazines were dropped, but *Astounding* was given a clean bill of health. Following the review, Tremaine was promoted to editor-in-chief with overall responsibility for all the remaining magazines, and that was when John W. Campbell, Jr., was appointed editor.

Eventually Street & Smith would drop all of its pulp magazines. *Clues* ceased in May 1943, *Western Story Magazine* in August 1949, *Love Story Magazine*, once the biggest selling of all pulps, in February 1947.³ Even the great hero pulps, *The Shadow* and *Doc Savage*, both ceased in summer 1949. But *Astounding* kept going. Its fantasy companion *Unknown* (by then *Unknown Worlds*) was sacrificed in October 1943 to secure sufficient paper for *Astounding* during wartime rationing.

Street & Smith moved away from fiction magazines and increasingly *Astounding* felt an anomaly, but they left it alone because it made money and was successful. However, in 1961 came another threat. Street & Smith was taken over by publisher Condé Nast. *Analog*, as it had become in October 1960, was the new publisher's only digest magazine, and it did not fit into the production process, especially for the advertiser's plates. *Analog* had to become a slick like its companions *Mademoiselle*, *Vogue*, and *Gentleman's Quarterly*. This change lasted for just two years, March 1963 to March 1965, when *Analog* reverted to digest size. It is perhaps surprising that Condé Nast kept *Analog* for as long as it did, because it was always the cuckoo in the nest, but a sufficiently popular one. The magazine not only survived the death of John W. Campbell in 1971, it positively thrived under the new energy injected by Ben Bova. Nor should we forget the support of Campbell's assistant/managing editor and all-round factotum, Kay Tarrant, who kept the wheels turning throughout the decades, allowing Campbell to work his magic, and who sustained the magazine after Campbell's death until Bova's appointment. Tarrant

was another record holder. When she eventually retired, with the October 1973 issue, she had served *Analog* for over 35 years and some 428 issues!

Condé Nast sold *Analog* to Davis Publications from its September 1980 issue, and it was thereby welcomed into a family of digest magazines that included *Asimov's SF*, *Ellery Queen's Mystery Magazine*, and *Alfred Hitchcock's Mystery Magazine*. This quartet has stayed together ever since, through two more changes of publisher, a degree of safety in numbers with their fortunes now bonded together.

Although under Clayton and Bates *Astounding* was a pure pulp magazine encouraging stories of adventures in space and time filled with monsters and macho heroes—pure space opera in effect—this was tempered under Tremaine and more so under Campbell. The magazine has remained true to its vision under Campbell, publishing both cutting-edge fiction and state-of-the-art science articles, but has not hesitated at the chance to publish tales of super-science when the opportunity allows.

One reason for this consistency is the remarkable longevity and loyalty of its contributors, some of whom have remained with the magazine for a lifetime. The all-time champion is Jack Williamson. Although he contributed fewer items after the 1950s, his name remained closely associated with *ASF* for seventy years. His first appearance was in the March 1931 issue and his last—his sixty-ninth—in January 2001, 839 issues later. Many of *ASF*'s leading contributors remained loyal for years. Hal Clement's appearances spanned almost sixty years (June 1942–January 2000), L. Sprague de Camp's almost fifty-six years (September 1937–May 1993), whilst both Charles Harness (August 1948–December 2003) and Isaac Asimov (July 1939–September 1991) were contributors for over fifty years. Dean McLaughlin has been contributing since July 1951 and last appeared here in July 2008, and former editor Ben Bova passed his fifty years association with the magazine in May 2012.

³ Both *Love Story* and *Western Story* were revived by Popular Publications which published them until 1954.

In the April 2005 issue, in “Analog Computing,” Stephen Gillett compiled a set of statistics to show the most prolific contributors to *ASF*, covering fiction, essays and artwork. His data was calculated up to the issue for June 2004, but although it is now eleven years old, it still presents a fairly accurate picture. In this article, as I’m talking about *Analog*’s one thousand issues, I thought it might be interesting to not simply update Gillett’s data, but present it in a different form. Who has appeared in the most issues? This will show a slightly different slant. After all, a four-part serial, for example, will count as four issues toward that author’s total, although it’s only one item. On the other hand, if an author, or artist, has more than one piece in an issue, it still only counts as one issue. I have also kept track of the total contributions, though, so we can compare the two, and I’ve included items such as book reviews, regular columns and editorials which Gillett excluded.

Thanks to the help of our esteemed editor, I have been able to include details up to and including this June 2015 issue. It has been a big task to agree all of these totals, and I ought

to include a caveat here that I might have missed or misallocated the occasional item, although I have checked all the data several times.⁴ I’d welcome hearing from anyone who has a query on any of the figures. They cover all contributions, including works under pseudonyms, except minor fillers.

It is no surprise that those who have regular columns in the magazine would rack up larger totals than occasional contributors of fiction, and the two longest serving editors, Campbell and Schmidt, therefore have the odds-on chance of having appeared in more issues than anyone else. And yet that isn’t the case. Anthony R. Lewis’s “Upcoming Events,” which began as the “Analog Calendar of Upcoming Events,” has been appearing since March 1974, missing only the January 1976 issue. This makes Lewis the most regular contributor and, with 480 columns, has appeared in more issues than anyone else—that’s almost half the magazine’s run and over half its lifetime. The only one to beat him in terms of total contributions is John W. Campbell, Jr. who, under his own name and three pseudonyms, has appeared with 509 items. Because more

Table 4. Contributors who have appeared in the most issues, 1: Columnists

Contributor and Primary Column	Total Columns	Other Non-Fiction	Fiction	Other Items	Total Items	Total Issues
Anthony R. Lewis, “Upcoming Events”	480	-	1	-	481	481
John W. Campbell, Jr. “Editorial”	409	81	17	2	509	438
Stanley Schmidt, “Editorial”	375	4	19	11	409	396
Thomas A. Easton, “The Reference Library”	341	15	13	-	369	355
P. Schuyler Miller, “The Reference Library”	290	-	15	16	321	321
Jay Kay Klein, “Biolog”	184	-	2	-	186	186
John G. Cramer, “The Alternate View”	176	4	-	-	180	180
G. Harry Stine, “The Alternate View”	118	36	15	2	171	164
Ben Bova, “Editorial”	67	21	37	-	125	129
Jeffery D. Kooistra, “The Alternate View”	90	1	15	-	106	105
Richard A. Lovett, “Biolog”	33	56	41	1	131	91

Note: Miller began “The Reference Library” in the October 1951 issue but had already been contributing a regular untitled book review column since October 1950 and scattered reviews since April 1945. The earlier columns are thus included in the first total and the earlier individual reviews under “Other items.”

⁴ I must thank in particular William G. Contento who maintains a continuous index to all SF books and magazines for *Locus*, the newspaper of the SF field (<http://www.locusmag.com/index/>). He kindly supplied me with a sub-set of data for *ASF* against which I was able to double-check my calculations.

than one appeared in the same number, these are spread over 438 issues.

All of this is detailed in Table 4. This shows the total number of issues in which columnists have appeared, and identifies their regular column, but also includes any other contributions of fiction, non-fiction and "other." This last includes one-off book reviews, obituaries, and minor material, but excludes small filler items. As with all of this set of tables, the totals exclude items reprinted from earlier issues of *ASF* but include items reprinted from another source.

The regular columnists account for the top ten contributors, but although most of those in Table 4 also contributed fiction, Lovett and Bova being the most prolific, their contributions are dominated, for the most part, by their columns. So, who are the most ubiquitous contributors without regular columns, again measured by the number of issues in which they have appeared? This is set out in Table 5. Remember that here each serial episode counts toward the number of issues, but a serial only counts as one for the number of contributions. It includes all works published under pen names. The table shows that the most prolific contributor of fiction is Jerry Olton, with 92 stories and counting, but because many of Poul Anderson's contributions

were serials, and he also contributed some articles, he has appeared in more issues—at least for the present.

It is perhaps not surprising that authors with the staying power to appear in so many issues have been around for some years, which is perhaps why Table 5 contains so many authors from the Campbell era and earlier. This serves only to emphasize the achievements of both Jerry Olton and Michael Flynn who have made their sales in a shorter period—albeit over thirty years ago. Olton first appeared in the November 1982 issue and Flynn in February 1984 (as Rowland Shrew) but, because of *ASF*'s longevity, it still feels fairly recent!

Sadly no women appear in this list. The highest placed female contributor is C. L. Moore, although most of her contributions were hidden as collaborations with her husband Henry Kuttner as either Lewis Padgett or Lawrence O'Donnell. Authorities still disagree on how many of those stories Moore wrote on her own, so her tally is somewhere between 41 and 44 issues. Otherwise the highest female author with stories entirely under her name is Maya Kaathryn Bohnhoff who has appeared in 24 issues to date, with 23 items. Pauline Whitby, who contributes variously as Paul Ash or Pauline Ashwell, has appeared in 21 issues (with 21 stories).

* * *

Table 5. Non-columnists who have appeared in the most issues, 2: Fiction and Essays

Contributor	Total Fiction	Non-Fiction	Other Items	Total Items	Total Issues
Poul Anderson	74	5	2	81	96
Jerry Olton	92	1	-	93	93
Christopher Anvil	83	-	-	83	83
Randall Garrett	66	1	-	67	70
Isaac Asimov	46	18	-	64	70
Jack Williamson	40	5	1	46	69
L. Sprague de Camp	26	19	17	62	66
Murray Leinster	50	3	-	53	63
Mack Reynolds	46	-	-	46	59
A. E. van Vogt	46	-	-	46	59
Willy Ley	3	50	-	53	56
Michael Flynn	50	7	2	59	55

Table 6. Artists in the most issues.

Artist	First appearance	Most recent/ Last appearance	Total issues
Frank Kelly Freas	September 1953	July/August 2003	256
Vincent Di Fate	August 1969	June 2015	222
John Schoenherr	June 1958	August 1983	148
Paul Orban	October 1933	August 1954	142
H. R. van Dongen	August 1951	August 1985	131
Leo Summers	January 1959	mid-September 1983	123
Broeck Steadman	May 1978	April 2010	116
Edd Cartier	June 1939	October 1955	110
Janet Aulisio	March 1977	July/August 2002	102
William R. Warren	June 1985	June 2009	99
Jack Gaughan	March 1972	August 1985	96
Nicholas Jainschigg	mid-December 1984	March 2008	96
Hans Wessolowski	January 1930	November 1939	81
Hubert Rogers	February 1939	January 1956	79
William Timmins	September 1942	December 1950	63
John Allemand	December 2002	January/February 2015	61
Charles Schneeman	July 1935	November 1952	60

Note: This Table includes only original work and does not count any reprinted artwork or standard headers.

Thankfully the female presence does register with regard to artists, just! Table 6 shows how many issues the leading artists have appeared in, whether for the cover or interior work. One issue just counts as one, regardless of how many stories the artist illustrated.

Since the cover is usually the first aspect of each issue that readers see, the cover artist can have an influence on sales, despite the old adage that you can't judge a book by its cover. It seems only fair, therefore, to recognize the cover artist, and Table 7 lists those

Table 7. Artists with the most covers.

Artist	First cover	Most recent/ Last cover	Total covers
Frank Kelly Freas	October 1953	February 2003	126
John Schoenherr	June 1960	August 1983	75
Vincent Di Fate	November 1969	June 2015	59
Hubert Rogers	February 1939	April 1952	58
Howard Brown	October 1933	November 1938	53
William Timmins	September 1942	December 1950	53
H. R. van Dongen	August 1951	August 1985	47
Hans Wessolowski	January 1930	August 1938	41
David A. Hardy	June 22, 1981	January/February 2014	39
Bob Eggleton	July 1992	September 2013	28

Note: This Table includes only original work and does not count any reprinted artwork or standard headers.

who have provided covers for the most issues.

What stands out in this set of tables is the number of contributors who have remained loyal to the magazine over the years, even with the intense rivalry with *Galaxy*, which developed during the 1950s. From Jack Williamson to Jerry Olton, from Kelly Freas to John Allemand, these are all individuals who, whilst they might also contribute to other magazines, made their reputations in *ASF* and, by doing so, made the magazine's reputation. It was that regular consistency of both the contributors and the magazine that allowed the development of major stories and series. What's more the inclusion of serious, extrapolative, and challenging articles about developments in science and technology, even when it was such extremes as dianetics or the Hieronymous Machine, attracted interest from the scientific establishment and gave *ASF* a greater level of credibility than other SF magazines. It still has the highest paid circulation of any of the SF magazines, and a significant number of readers are scientists, at least if one goes by the letters in "Brass Tacks" (the magazine's longest lived feature, which has been around since the December 1933 issue).

ASF was, for much of the twentieth century, the primary source for major science fiction stories and serials. To possess a full set of the magazine is to own much of the history of science fiction for the last eighty years or so. In its one thousand issues, it has published over 5,600 stories and serials and over 2,800 nonfiction essays, editorials, and features by over 1,200 contributors. I'm sure we each have our own favorite items—far too many to list.

The magazine has its own voting system, another long-running feature, the Analytical Laboratory, or AnLab as it became popularly known. It began with the March 1938 issue and ran through to October 1976. At that time it was voted on an issue-by-issue basis, and there was often a question about its reliability. Campbell used it as a system to pay a bonus to the winning author, but just how much it

reflected the view of the readers is questionable.⁵ It favored serials making it difficult to compare stories in issues with serials and those without. It was revived as an annual, and probably therefore a more reliable, poll in 1979 (covering 1978) and continues to this day. This means that there is a voting system covering seventy-six of the magazine's eighty-five years. It misses out on the first eight years, which included such early classics as "Side-wise in Time" by Murray Leinster, Campbell's own "Twilight" and "Night," written as Don A. Stuart and even H. P. Lovecraft's "The Shadow Out of Time." Who knows what they would have scored.

The AnLab represents the views of readers at the time, so it is a snapshot of opinion in that year, or originally in that month. As a result it provides a gut-feel reaction to stories rather than a longer-term assessment. It often surprises me what stories, now long forgotten, received high votes and what stories, now considered classics, were not recognized at the time. Isaac Asimov's "Nightfall," for instance, long regarded as the best story from science fiction's so-called Golden Age, must have received several second, third, and even fourth-place votes because its final tally was 2.45.⁶

On just three occasions a story or a serial episode received the perfect score, where everyone voted it in first place. It happened with the first episode of Robert A. Heinlein's "Beyond This Horizon" (April 1942), which was published under the alias Anson MacDonald, so not all readers knew the true identity of the author. The second episode, though, received a score of 2.0, so evidently there were readers who preferred A. E. van Vogt's "Asylum," which ran the serial close with a score of 2.10.

Only one story, complete in an issue, received the perfect score of 1.0 and that was "Nerves" by Lester del Rey in the September 1942 issue. But the first to receive the perfect 1.0, was episode two of Heinlein's "Methuselah's Children" (August 1941). In fact, the votes for all three episodes, when averaged

⁵ When Ben Bova decided to drop the AnLab he remarked that it had "been a long, long time since we had received as many as one hundred votes." (February 1977, p. 6)

⁶ In the original "Analytical Laboratory" Campbell simply gave a story a score of 1.0 for that voted the best in the issue, 2.0 for second and so on, and then averaged out the totals.

and also weighted to allow for the number of stories in each issue, means that “Methuselah’s Children” received the best score of any serial in *ASF*.⁷

There’s something about those two stories that typified Campbell’s *Astounding* and to some degree still underscores the magazine’s general ethos. In “Nerves” there is the dedicated resolve of an atomic plant’s medical officer under pressure to save the plant (and most of the United States’s eastern seaboard) when it threatens to go into meltdown,

whilst in “Methuselah’s Children” we see the emergence of a family of long-lived individuals as a result of selective breeding. Well Campbell (and for that matter Tremaine and successive editors) have needed that steel determination to sustain *ASF* through difficult times and through the development of key writers capable of producing different and highly individualistic fiction, *ASF* has itself become one of Methuselah’s Children.

Onward to the next thousand. ■

⁷ For a full study and analysis of the AnLab scores see “The Analytical Laboratory, 1938-1976” by William Sims Bainbridge, *Analog*, January 1980.

Ships in the Night

Jay Werkheiser

"Whatcho drinkin', offworlder?" Well, the guy sure ended the awkward silence stage quickly. Conversations stifled by my arrival resumed in hushed voices. He appraised me with his eyes and apparently found me wanting. I put on my (hopefully) disarming grin and asked, "What do you guys brew around here?"

"White ale."

"What's it made from?"

"The hell do I look like, a botanist?"

"Calm down, Zhake." The bartended stared him down, then turned his attention to me. "It's fermented from a gen-modded rice hybrid."

I nodded to the bartender. "I'll try it."

"Aincho never been on Nouvelle Terre before?"

"It's been a few generations in your frame. Most of the population was still living in orbital habs."

Zhake grunted. "Last ship came by, I was just a boy. Wasn't yours, then."

"Nope. Mine does a high-c circuit, long trips and heavy time dilation."

The bartender plunked a glass in front of me. The nearly colorless liquid foamed like beer and had a similar aroma. I took a long draught, savoring the flavor and texture. I nodded. "It's good." I swallowed another gulp and put the half-full glass on the bar.

Zhake cracked a grin. "Yer all right, for an offworlder."

"This is the best part," I said. "Sampling what new worlds have to offer. New cultures, new sights, new tastes."

"Yeah?"

"Like on New Hope, where they make a minty liqueur distilled from the blood of some sort of mushroom-shaped trees."

"Uh, blood?"

"It's complicated." I glanced around and noticed a handful of nearby patrons had turned their attention to us. I downed the remainder of my drink and pounded the glass onto the bar just a bit too loudly. A moment's eye-lock with the bartender sent him scurrying for another.

"Where else you been?"

"Anyplace that has a high-c particle cannon. Like Haven, where they use meat with reversed proteins. Has the sweetest aftertaste, but you can't eat much, and you need to take an enzyme pill with it."

"So it's true, then. You spacers live your whole lives wandering the stars, never putting down roots." He brushed the idea away with his hand. "That ain't no kind of life."

"The colony worlds are like the city states of ancient times, separated by vast tracts of wilderness. Travelers and traders are what held them together, made them a civilization."

"Helluva wilderness to cross."

I held my newly filled glass aloft. "This is what makes the long trips worthwhile."

Zhake squinted at me. "Must be boring."

"Usually is. But there was this one time . . ."

I took another long pull from the glass.

"What happened?"

I looked sheepishly at the growing crowd.

"Ah, nothing. I shouldn't say anything."

"What? An engine malf? Pinged by a pebble at high-c?"

"Nah, nothing like that. It was a pretty normal flight; it was just luck we noticed it at all."

"Noticed what?"

"Well, I do in-flight nav, which is pretty boring because the particle beam does all the aiming, and we can't really steer much at high-c." I noticed that the conversations had again quieted, and every eye was on me. "I mostly take parallax measurements of nearby stars to make sure we're on course."

"What did you see?"

I took another gulp of the fizzy drink, savoring its light, dry flavor. "This particular run took us past two red dwarf systems, within a couple light years of each. UV Ceti and Lacaïlle something or other."

"Nothing special about red dwarfs. No colonies at any of 'em."

"Actually, old Earth only ever sent unmanned probes to a few of them. Theory is, planets would have to be too close to the star to get enough warmth. That close, you'd get problems like tidal locking and radiation from flares."

His face slacked as he tried to follow me. "No sense wasting probes, then."

I nodded. "These two were just as dull as you'd expect. The first of them was a binary, redshifting to the rear right on schedule by my math. I reached for my tab to log the spec data, and I must have bumped the spectroscope with my elbow. I didn't know it at the time, but I jostled it off target by an arcsec or two. My apprentice Dar found it on the next shift."

I filled my bulb from the coffee tap and settled into an empty seat. Most of the crew slept during 4-shift, so the lounge was quiet. I unrolled my tab, ready to do a little reading, when it buzzed. I tapped the comm app and said, "What's up, Dar?"

"I've got a heavy blueshift on the spec." Her voice warbled with insecurity. "What should I do?"

"Damn it, kid," I said, "you're aimed at the wrong star. If you've been drinking on shift again—"

"I'm clean, Brad. Honest. I got UV Ceti centered in the sighting scope."

"It's a close binary. Did you subtract out the orbital Doppler?"

"This isn't my first trip, you know."

"Second. You're still a newb."

"Well, whatever this is, it's blueshifted hot. Like point six c. In our frame."

"Jeez. That can't be right." I let out a long breath. "Okay, I'll be up."

The instrument blister was attached to the cargo ring, which doesn't rotate like the hab ring. It was a short trip up the access tube to the hub, then back out the cargo tube to the blister. Dar was floating next to the spec mount, looking sheepish.

"This better be good," I said.

"Take a look, Brad."

I peered at the spec screen. "Jeez, Dar, those are ionized helium-4 lines. You're not even aimed at UV Ceti."

"That's just it, Brad. What the hell *am* I looking at?"

I didn't have an answer for that. I looked through the sighting scope. There was UV Ceti, right in the middle where it belonged. I zoomed tighter, and again. "Hello there. What are you?"

"What is it, Brad?"

"I don't know." I unrolled my tab and tapped the captain. "Hey Mehgen, I got something you should see."

She came on, voice only, her words slow and groggy. "Better be important."

"I got something strange near UV Ceti."

"Who gives a rat's ass?"

"It's a tiny point of light, hot and fast, coming toward us."

"Flare?"

"Not at high relativistic speed. Can you turn the big scope on it?"

"Let me check with Kam. Meet me in the lounge in an hour."

I rolled my tab and turned my attention to Dar. "Keep your eyes on it."

I headed back to the lounge and tried to focus on the novel I'd picked up on Haven. I

stared at the same few paragraphs until the captain arrived. She opened a screen on the table in front of me without a word.

"What am I looking at?"

"Your annoying little spark. Look closely." She slid her fingers across the screen, zooming on an intense white smudge. "See that dark spot in the middle?"

"Yeah."

"It's a ship."

"Wait a minute." Zhake's eyes narrowed. "Who the hell would go to a red dwarf? Ain't nothin' there."

I let my lips curl into a small grin. "We didn't know at first." I took another long drink. "What do you think it was?"

He rubbed his chin for a long moment. "Some idiot lost his way looking for one of the colony worlds?"

"Nah, their courses are plotted by the particle beamers." The voice came from behind Zhake, in the crowd that had gathered around us.

I nodded. "Now there's another clue. They weren't flying by particle beam. They were using fusion."

"Right, the helium spec."

"Maybe one of those old robot probes," Zhake said. "They used some kind of fusion thrusters back in those days."

Another voice from the crowd said, "But they couldn't get close to high-c."

"Ghost ship." I spun my head to stare at the bartender, who stood, arms folded, defending his statement with stoic silence.

I emptied my glass, giving the crowd time to think about it. "What makes you say that?"

"Old guy worked here years back used to tell stories he'd heard from spacers in his day. Stories from before we had the high-c particle beams, about explorers setting out from old Earth in fusion ships. About a lost expedition, never heard from, maybe wandering the stars to this day."

I stared at my empty glass for a moment. "We thought about that too. But here's the kicker. After a couple dozen shifts, we had enough info to plot their course."

Zhake spoke up, his voice hushed. "They were coming after you?"

"Nah. They were heading for Lacaille what's-its-number."

"From one red dwarf to another? Nobody does that."

"No human," I said.

"Aliens?" Mehgen stared me in the eye. "You're telling me it's an alien ship?"

"You have a better guess? One that explains their flight path? The fusion signature no human ship has ever used? The high-c speed no recorded fusion ship has ever reached?"

"Why didn't anyone ever see them before? We're not even carrying any real scientific instruments."

"No one's ever looked," I said. "No one cares about stars without colonies. It was just dumb luck our spec was aimed at the wrong place at the right time."

She blew out a long breath. "Okay, say I buy into your theory. What do you suggest we do?"

"Contact them, of course!"

"How?"

I met her steely eyes and realized that she knew I hadn't thought it through. I got up to refill my coffee bulb to buy time. The empty light flashed. "Damn it." The damned thing mocked me, blinking on and off. Blinking.

Aha!

"We can aim the signal laser across their path. Modulate the beam in, I don't know, prime numbers or whatever they do in alien invasion vids."

Her eyebrows arched just a bit. "Not a bad idea. We should be able to project their position, assuming they maintain a constant acceleration. Might be easier to aim while their proper motion is still relatively small. Closer they get . . ." Her gaze went distant.

I knew better than to disturb her, so I set about refilling the coffee. When I finished, I found that she had left the lounge.

Things happen slowly on a high-c transit. Calibrating and aiming the laser, deciding what to transmit, waiting for the signal to get there and back, and before you know it, nearly a year had passed. Light can seem very slow sometimes.

Shipboard routine drifted back to its equilibrium state. I finally finished that novel, and the shifts melted away. I was putting in my treadmill time during a 5-shift when Mehgen tapped me. "Get up to the instrument blister."

"Dar's on duty."

"Your aliens got the message."

"How do you—never mind, I'll be right up."

I was up the nearest access tube and out to the cargo ring before I even had time to process the information. *First contact!*

"What's going on?"

"Good, you're here." Mehgen pointed to the sighting scope. "Take a look."

UV Ceti had long since faded to the rear, so the alien ship was an intense spark against the dark background. Except now it was a streak rather than a dot.

"What happened?"

"They turned," Mehgen said.

"They're changing course mid-flight?"

"Pics from the big scope should be coming in soon but yeah, we're pretty sure they're moving closer to us."

"How close?"

"It'll take a while to track their new course."

"Wait, they were coming right atcha?"

"Nah. It's not easy to change direction at high-c. They did more than we could, a few degrees deflection, but the best they could manage was a quarter light year at closest approach."

"How close is that?"

"Maybe fifteen, twenty kilo-AU."

"That doesn't help."

"Let's just say we still needed the scope."

The bartender slid a plate onto the bar in front of me. "It's a sampler. Thought you'd like to try some of the foods we have around here."

"Thanks." I picked up a deep fried strip of something starchy and bit into it, savoring the complex flavors.

"What I'm wondering," the bartender said with a suspicious squint, "is how they got up to high-c using fusion."

I met his gaze. "We figured it was a fusion ramjet."

He nodded. "Heard of them. Old Earth never could get them to work right."

"Looks like these beings did."

"So what happened?" Zhake asked.

"Like I said, things happen slow on the high-c circuits. It was another few dozen shifts before we knew there was a problem."

"What kinda problem?"

"Well, they'd been taking themselves off course to come check us out. Sooner or later they had to head back toward Lacaille."

"What, they turned around too soon? Never got close?"

I sampled a tiny pastry filled with some sort of ground meat. "Too late, as it turned out."

"How was that a problem for you?"

"They were using fusion engines, remember?"

"Ah," the bartender said. "You were in their exhaust plume."

"I don't see why it's a problem," Dar said. "Our shielding can handle cosmic radiation at high-c. Can't be worse than that."

I slammed my coffee bulb onto the table. "Most of our shielding comes from the plume of ions from the particle cannon. That's in front of us. The alien's exhaust is coming in from the side."

"Yeah, but we have magnetospheric shielding, too."

"Sure. And what happens when all those exhaust particles get dumped into the plasma at once?"

"Uh . . . it heats up?"

"You did manage to learn something."

"So the captain is worried about the ship overheating?"

I blew out a sigh. "No, no, no. Plasma leaks away too quickly at higher temp, and we don't have enough gas on hand to replace it."

"That's why the captain has been a pain in the ass lately."

"What do you mean, lately?" I gave her a mischievous grin.

"How can you joke around? We're going to die."

"Or at least glow in the dark."

She huffed.

"Don't get your pressure seals undone. We'll come up with something."

Something is a rather vague thing, though, in the face of the very concrete mortal danger looming. Before long, nerves frayed and tempers flared. I found my playful jabs at Dar becoming less and less playful. Then one particular 3-shift, Dar interrupted me in the instrument blister.

"Hey Brad, I have an idea."

"Dammit kid, can't I just serve my duty shift in peace for once?"

"Just listen." She swung her arm in anger, setting herself into a slow rotation.

I laughed.

"Don't be an ass."

"All right, what's your big idea?"

"Their ramjet uses a giant electromagnetic field, right? So why don't we use our magnetosphere to push on it? Plasma produces a magnetic—"

"Won't work. They're not nearly close enough for that."

"But you said their ramjet field had to be huge."

"Not that big." I laughed again. "What made you think . . . wait, are you crying?"

She swatted at her eyes. "No. I'm fine."

"Look, I'm sorry. I know I've been—"

"Aren't you terrified?"

"Hell yeah. Believe me, I would have been thrilled if you were right."

"I can't handle just sitting and waiting. I want to do something, even if I have to throw ions at them by hand."

My back went rigid. "Throw ions. That's brilliant!"

"What?"

"The ion beam that's pushing us. From the particle cannon back on Haven. If we can deflect it, we can send all those ions into their magnetic field. That should push them away."

Hope flashed on her face for the first time in far too long. "Will that work?"

"We won't change their path much, but we only need a couple of arcsecs."

"Tap the captain right away!"

"So that's it?" Zhake's eyes narrowed suspiciously.

"The actual doing of it wasn't interesting. An engineer did a few calculations, a programmer wrote a quick app, Mehgen pushed a few buttons."

"But you didn't get to talk to them?"

"Who, the aliens? We didn't even get a good look at the ship. They passed too fast, too far away."

"So you never found out why they did it? Why they threatened you?"

"Threatened? We just assumed that they didn't know we were in danger."

"How could they not know?"

"They didn't use a particle beam to reach high-c, so they didn't have an ion plume to protect them from cosmic rays. Maybe they didn't need it. Maybe they figured we didn't either."

"Humph. That's a lot of supposin'."

"I suppose so. I'd rather believe that than the alternative."

The bartender spoke up. "That there's aliens out there who would rather kill than talk."

I nodded, looking down into my mug. "Lander'll be launching soon." I downed the last of my brew and stood. "Thanks for the hospitality."

I took my time walking back to the lander. The ale had put a bit of a wobble in my step. I absorbed the scenery, mostly gen-modded Earth life and prefab habs. My last view of a living world for a couple years.

Yes, it was like an ancient village on old Earth, isolated, self-sufficient, and surrounded by a vast wilderness. Only this wilderness was vaster and more barren than the ancients could have imagined. Isolated civilizations stagnate.

The lander's cargo bay doors were still open, and a familiar form tinkered at the entrance.

"Hey, Daria," I said. "You ever heard of fusion ramjets?"

"I'm not a newb."

"You think you could deflect one with ions from the particle beam?"

"Ha. Particle density's way too low. Even if you could, recoil would push you out from behind your shielding ion plume. Whatever gave you that idea?"

"Just talking with the locals."

"That's all you ever do."

"We're modern day minstrels, Daria, wandering from community to—"

"Yeah, yeah. Planting the seeds. Curiosity and exploration."

"Go ahead, scoff. We'll be gone for centuries subjective. These people, their descendants will explore beyond the few meager colonized star systems. If not them, the people of Haven, or New Hope, or—"

"Get aboard and help with the preflight checks."

I sighed. "Sure thing."

Who knows what they might find out there?

Generations flash by in but a few years subjective on the circuit, but those years will peel away shift by interminable shift. Sometimes high-c travel feels slow. ■

The Audience

Sean McMullen

A report from humanity's only starship should be very formal, but this report will have to be a story. Humanity's future will depend on my ability to tell a good story, four and a half thousand years from now, so I must keep in practice. This will also be my last contact with Earth, and I want to give you an accurate and definitive account that is still a good read. Official reports are always so boring.

The *Javelin* was built in lunar orbit, and the crew was selected on a list of criteria longer than most novels. My background is in disaster recovery for large spacecraft, and that got me into the crew. Why? It is because disaster recovery experts need to have a working knowledge of literally every system: how to repair it, how to make something else do the same job, and how to do without it and not die. I had been on the disaster recovery design team for the *Javelin*, and I met all the other criteria. That put me just a whisker ahead of the nine thousand other candidates for the fifth and last place on the crew.

Uneven numbers are good for breaking deadlocks when votes are taken, so there were

five of us aboard the *Javelin*. Our life support and recycling units had been over-engineered to last a century with us awake, and almost indefinitely with the crew in suspension. Five months of acceleration were followed by fading away into chemically induced bliss, twenty years of nothingness, then a long struggle out of jumbled, chaotic dreams. By then, we were nowhere near Abyss and still faced another five months of deceleration. One two-hundredth of the speed of light may not sound like much, but we held the record for the fastest humans alive about a hundred times over.

For some irrational reason, I had expected to see something when I looked out at Abyss, yet only an absence of stars was visible, slowly rotating as the gravity habitat turned. My subconscious kept screaming that it was a black hole, and that we would be sucked down, mangled and annihilated, but the rational part of me knew otherwise. Abyss was just a gas giant planet about the size of Jupiter, with three large moons and a thin ring system. It was special because it was not part of the Solar System.

We gathered at the gallery plate, celebrating our insertion into orbit around Abyss. Landi, the captain, was standing beside me, and we

were playing our favorite game. I would make a grand statement, and she would try to cut it down to size.

"We know it's there because we see nothing," I said, the frustrated author in me always on the lookout for a nice turn of phrase.

"That's how it was found," said Landi. "Stellar occultation. Stars that should have been visible were not."

"This is the first voyage beyond the Solar System, but we have not left the Solar System."

"We're a tenth of a light year from the Sun, that's hardly the Solar System."

"We are in the Oort Cloud, the Oort Cloud orbits the Sun, so we are still in the Solar System."

"But Abyss is only passing through the Oort Cloud, it's not orbiting the Sun. We have matched velocity with Abyss so we are no longer part of the Solar System."

"But we are in the Oort Cloud, so we are still *within* the Solar System."

"Abyss is less than a fortieth of the distance to Alpha Centauri."

"Which is a hundred times farther away than Pluto."

"Draw," was the verdict of Mikov, our geologist.

Saral and Fan clapped. We had been selected to be compatible yet diverse, complimenting each other's skills. For the ten months that we had been awake, it had been like a working holiday with close friends. For my part, I would have happily spent the rest of my life on the *Javelin*.

"Coffee break's over," said Landi. "Time to refuel."

The *Javelin* expedition had a single point of failure, which is something that disaster recovery people hate. There was enough reaction mass to get us to Abyss and stop with our tanks practically empty. All the gas giants of the Solar System had ring systems of ice, so the designers had gambled on Abyss having rings as well. The gamble had paid off, so we could refuel and eventually go home.

Had the designers been wrong, there were two disaster recovery plans. One was for us to go into suspension once our explorations were done, and wait decades, or even centuries, for a follow-up expedition. If the moons of Abyss turned out to be interesting, we had the alternative of living out our lives there.

Mikov and I took the shuttle into the edge of the ring system, trailing a hose with a thermal lance and grapple on the end. This I attached to a chunk of ice about the size of an ocean liner during our first spacewalk. In doing so, I made humanity's first contact with an extra-solar world.

"That's one small gloveprint for a man," I began.

"And about two months of your pay docked if you finish that sentence," said Landi in my earpiece. "Lucky this is not going live to Earth."

"Okay, okay, I have touched a star and it is ice," I said.

"Once more, this time with a sense of wonder. The taxpayers back home want significant moments, not corny jokes."

The thermal lance got to work, melting the ice and sucking the water into the half-mile hose leading to the *Javelin's* tanks. It would take several weeks and dozens of spacewalks to collect the millions of tons of reaction mass needed to refill our tanks, but propellant to get home had priority over everything else.

"Hard work to make an exciting story out of a good outcome, eh Jander?" said Mikov.

"True, disasters make the best stories," I replied. "My work is to make sure I have nothing to write about."

The term science fiction was coined three hundred years ago, but evolved into what the academics call reactivity literature. How do humans react to the unknown? I write about it as a hobby. More to the point, I had been published. Some selection subcommittee decided that having an author in the crew might be a good idea.

Although weak, the gravity of the ring fragment had attracted some ice rubble to its surface, and I selected a fist-sized chunk to take back to the shuttle. With our ticket home now more or less secure, the science could begin. The shuttle made the short hop back to the *Javelin*, and I handed my insulated sample pack to Saral, the biologist, for analysis.

I was lying on my bunk in the gravity habitat, having a coffee and watching some drama download from Earth, when Mikov rushed in.

"Saral's discovered cells!" he exclaimed. "The ice is *full* of bacterial cells."

This was more significant than, well, nearly anything in recorded history. Life existed beyond the Solar System. We had proof.

"The cells are all dead, of course," said Saral on a downlink to Earth some hours later. "The three chain molecules that pass for DNA in these things have been trashed by billions of years of cosmic ray exposure. I can get firmer dates from the samples, but that will take longer."

"Billions?" asked Landi, playing the role of an interviewer.

"From my first guess analysis of the rate of cosmic ray impact in deep space compared to the damage to the Tri-DNA, I would stand by billions."

"Mikov, can you talk about the astrogeology?"

"I would only be guessing," he began.

Landi killed the microphone.

"This is a press conference, and I am the press!" she said firmly. "Start guessing."

Mikov was rather pedantic by nature and had very little sense of occasion. He was clearly not happy as the microphone winked back into life, but he took a deep breath and began.

"I think that at least one of the three moons of Abyss has a subsurface ocean, kept liquid and relatively warm by tidal forces from Abyss and the two other moons."

"Like Jupiter's Europa?"

"Yes. Billions of years ago an asteroid smashed into that moon and cracked the cover of ice over a subsurface ocean. Water and bacteria reached the surface through these cracks and froze. A later impact smashed some ice with bacteria into space, and some of it eventually reached the ring system."

"Ice with biological material from Europa has been found in Jupiter's ring system," added Saral.

This was all fairly dry and factual, even though the subject matter was nothing short of magical. Fan was the flight engineer so his opinion was not very relevant. Landi turned to me.

"Jander, you know a bit about everything," she prompted. "Can you pull all this together?"

In other words, tell the folks back home a good story.

"The bacteria samples were smashed out by impacts billions of years ago, but the life forms will have continued to evolve," I said off the top of my head. "Imagine what must have evolved down there by now."

"Are we looking at possible intelligence?" asked Landi.

"Could be."

"Civilization?"

"Not as we think of civilization. The locals would be cut off from the Universe, and tool-making is a definite challenge under water."

"Like, fire is out, so no heavy industry?"

"All true, but biological nanotech is possible. By using fabrication-layering, they could build entire cities. After all, most of the *Javelin* came from fabrication vats on the Moon."

"So that's where we are," concluded Landi.

"We still have weeks of refueling ahead of us here at the edge of the ring system, but we do have a fleet of sensor probes that can be launched at the three moons and put into orbit. They will tell us which moon has the ocean, and the first of those will be launched today."

Five weeks passed, and in that time, our probes showed that all three moons had subsurface oceans. Landi decided to send the shuttle to Limbo, the innermost of the moons. Aboard were Saral and Mikov, with Fan as pilot.

I have a good memory for facts and figures, which always helps in disasters when computer databases are not always available. I knew that the spacesuit boots of humanity had left first footprints on five thousand, seven hundred and three worlds within the Solar System. Most of them had been small asteroids and comets, yet the people wearing those boots had always said something profound or significant. Mikov was not inclined to be profound.

"There's a lot of ice down here," he said after stepping off the shuttle onto Limbo.

Landi was sitting beside me, watching the event on a display in the console room. She put a hand over her eyes.

"He said that deliberately," she muttered. "I should have put myself in charge."

"Why didn't you?"

"I'm the captain, and *this* ship is my ship."

"No good deed goes unpunished. So who gets first boot on Chasm and Styx?"

"Fan gets Styx."

"And Chasm?"

"You."

This was a surprise. I was not a high profile member of the crew.

"Why not Saral?"

"Sara! She's the biologist. By tradition the pilot gets first footprint. You are a pilot."

"I . . . have no interest in historical moments."

"Mikov has had Limbo, and Fan is liable to say something as boring as Mikov. You're our author, you of all people should get a first footprint."

"Many more men than women have made a first footfall, why not—"

"Jander, you get Chasm and that's my last word on it."

I dared not say that I owed Sara a favor, so I did not argue. Using our gravitational displacement satellites, we had determined that Limbo had an ocean layer ninety miles beneath its outer shell of ice. The shuttle's floodlights showed nothing more than shattered ice on the surface as Mikov took the contingency samples and Fan and Sara began to unload the instruments.

Lunch was being eaten on Limbo when I accessed one of the orbital probes. The radar sounding array was showing craters, cracks, and melt plains, and it looked very similar to Europa. I switched to the telescope and selected the visible light display. A single point of light stood out against absolute darkness. This was the floodlights of the shuttle, lighting up a tiny circle on the surface of Abyss. Landi looked across from her console.

"What are your thoughts at this historic moment, Mr. Author?" she asked.

"I was thinking how mundane historic moments can be. First footfall on a new world, and nobody even raises a sweat."

"I was just thinking along the same lines. Is this really why we worked so hard to get here?"

"Boring is good, excitement can kill," I said automatically.

Disaster recovery people always secretly hope they will never have any work, yet authors like a bang and a puff of smoke to make things exciting.

"So why did you volunteer, Jander? I mean, why really? Not that crap about standing on the edge of the frontier and gazing into the unknown."

I hesitated, as if thinking about my answer. I already knew that answer, but an instant reply would have made me seem cynical, and delays always raise the dramatic tension.

"To see the future, when I get back to Earth."

"Really? There are cryogen tanks for that sort of thing. It's a lot safer than coming all the way out here."

"Cryogen is for the rich, and I'm not rich. Now I'll get to see the future *and* collect forty-one years of pay. What about you?"

"I'm here to become famous," she said with an exaggerated smirk.

"Really? Just that?"

"Yes, I really am in it for the fame. How else could a ship's commander become a celeb? Everybody will want to know us when we get back, we won't be ignored like the cryogenic time-tourist nobodies who just have themselves frozen for a few decades."

"No sense of the wonder of strange new worlds?"

"Give me a break. Prospecting on comets and ice worlds in the outer Solar System is no different from what we're doing here. We may find a few live bugs, but we did that on Europa."

So, her enthusiasm and hype had all been for the cameras. It was a disappointment, but then maybe I was a disappointment to her as well.

Remote sensing with satellites can tell you a lot, but there is no substitute for sounding charges. The explosives had been measured to within a fraction of a gram, and they were designed to be delivered to a precise depth in the ice by a thermal probe, then detonated. Fan and Mikov spent sixty hours sinking ten charges, and anchoring seismographic sensors to filter data out of the reflected shockwaves.

Meantime, Sara worked on new biological material picked up on the surface, and again she got guaranteed headlines when she discovered something like a small jellyfish with tentacles and a nervous system. Her estimate on its age was a hundred million years. More to the point, it was an animal that could pick up things and manipulate them.

"What do its descendants look like today?" she concluded. "With luck, we may find out."

All of this was transmitted to the *Javelin*, and we passed it along to Earth on Homelink. Thirty-six days into the future, Sara's discoveries would trigger another media frenzy.

Strangely enough, I felt isolated and even a little annoyed. I was not quite at the frontier, I was contributing nothing. It was excitement without danger, I was not needed. No disaster meant my primary skill was of no use. As for

my writing, how many great works of literature were written about the actual discovery of DNA? The first lunar landing? The first atomic reactor?

My expectations were low when the time came for the first of the sounding charges to be detonated. Fan followed safety protocols and ascended in the shuttle to orbit Limbo. There was always a possibility that the charges would release major stresses that had built up in the ice. Mikov and Saral suited up and armed their jetpacks, in case they had to hover out of harm's way if any moonquakes were caused by the soundings.

"Okay, Limbo, show us what you got," said Mikov. "Detonating the charges at five second intervals, starting with . . . Alpha!"

The shockwaves would take seventeen seconds to reach the ocean layer.

"Beta."

At five seconds, realtime analysis reported ice with healed fissures, but little more.

"Gamma."

Ten seconds into the exercise, and the first of the shockwaves were over halfway to the ocean.

"Delta."

At fifteen seconds plus two and counting, the shockwaves were through the ice and into water. The lifesign telemetry from Ground Limbo suddenly flatlined. All that the *Javelin* was receiving was the carrier wave from the satellite relay network we had set up around Limbo.

"*Javelin* to Ground Limbo, *Javelin* to Ground Limbo," Landi called in her auto-calm voice. "I have registered an uplink outage. Comm-sats One, Two, and Three have positive, repeat positive transponder function. Over."

We waited through the light speed delay. There was no reply. Landi made several more attempts at contact.

"Jander, I'm getting a total outage of bio telemetry from the surface of Limbo," she reported. "No transmitters on the surface are down, and satellite relays all have positive, repeat positive carrier signal function."

"Shuttle to *Javelin*, what's going on with Ground Limbo?" Fan called in.

"*Javelin* to Shuttle, I have strong signals from Ground Limbo, but no lifesign telemetry."

"You mean Mikov and Saral are dead?"

"Nothing appears to have been damaged, but I read no, repeat no lifesigns."

"I request clearance to return to Ground Limbo."

"No, Shuttle, that's definite no!" said Landi, almost shouting into the pickup. "I've got a link to the maintenance crawler at Ground Limbo."

"Can you patch me the image—" began Fan, then his lifesign telemetry was cut off with a sound like a gunshot.

"Shuttle, I—what—status, what is your status?" stammered Landi. "Fan! Answer me!"

This was Landi under pressure, facing the absolute unknown. I called up the monitor screen for the shuttle. Fan's spacesuit was in the command seat, but nothing was behind the faceplate. A jagged chunk of ice was floating in the cabin.

"What the hell is that?" demanded Landi.

"I can display it, but I can't explain it," I replied.

"Taking command of Shuttle," said Landi, her fingers flickering over the console's control points.

Some seconds later the engines of the shuttle fired, and the chunk of ice was slammed against the back of the cabin.

"I'm betting the ice has the same mass as Fan," I said.

"Why?" asked Landi.

"Look at the Doppler reading on the shuttle. It's identical to before his lifesigns dropped out, after compensating for the fuel being used. Ice was exchanged for Fan's body."

"How? I don't understand."

"Neither do I, I'm just looking at the instruments. Drop the cabin temperature in the shuttle. Better still, decompress. The ice may tell us something."

We stayed awake sixteen hours into the next sleep cycle to do our investigations and send our report down Homelink. It would cause consternation when it arrived, but for now, it was just an excuse to get our thoughts in order.

Within the shuttle was a lump of ice with a mass of one-seventy pounds. It was the same as that of Fan. Analysis showed it to be not much different in composition to that of a comet nucleus. According to one of our robotic probes, that was the same as most ice in the rings girdling Abyss.

When we finally found time to examine the soundings data, we wished we had looked at it first.

"Something's down there," I said, displaying a cluster of tetrahedral blocks with ragged fractal

edges to Landi. "*This* is floating not far from the ice shell, according to the soundings. It has a very artificial look, and it's ten miles across."

"Volcanic basalt columns on Earth look artificial," she said, without sounding convinced.

"Does that thing look natural?"

Neither of us was in a position to say anything sensible. Nothing in humanity's science, explorations, and experiments covered anything like this. Another hour of computer enhancement and interpretation gave us higher resolution, but no answers.

"Give me some conclusions," said Landi, rubbing her face in her hands. "Tell that wild and florid imagination of yours to get out of bed."

She was too steady and sensible to cope with the improbable. As a battle commander, I could think of nobody better to have in charge, but this was not a battle. I was coping by imagining this as a novel, with myself as a character.

"Something beyond our understanding reacted badly to the sounding explosions," I said. "That something is in the subsurface ocean of Abyss."

"I worked that out for myself."

"It plucked our crew out of their spacesuits and took them somewhere."

"Where? Under the ice, into Limbo? First contact? *Take me to your leader?*"

"No. Ice from the ring system was in the shuttle's cabin. If you want a wild speculation, I'd say two more chunks of ice with the same mass as two humans were exchanged for Saral and Mikov."

"That means there should be two chunks of ice beside their spacesuits. We saw no ice."

"I didn't look. Did you?"

Landi put the monitor cameras through a panoramic sweep. There were indeed two large pieces of ice lying near the empty space suits outside the Ground Limbo habitat.

"Some sort of mass-exchange teleportation," said Landi, finally accepting the evidence but not understanding it.

"Limbo probably gets hit by the odd comet from time to time, like when it passes through the Oort Clouds of other stars," I said, pushing my imagination so hard that my head felt like it was heating up. "The Limbians seem to sense water and ice rather well. Perhaps they learned to detect ice beyond their world and move it around. The ring system of Abyss is dynamically unstable, so something is maintaining it artificially."

"You mean they keep it as a reserve of mass and momentum to deflect bodies on course for Limbo?"

"Only if those bodies are made of ice."

"Then how did it—they—whatever—sense us? Ground Limbo and the shuttle are not made of ice."

"But the crew are mostly water." I was tempted to add *so are we*, but it was hardly necessary.

"What can we do?" asked Landi, her very orderly brain probably on the edge of seizing up. "Like, if the rings of Abyss are a sort of alien ammunition belt, then we're like a couple of ants stealing bullets."

"If I discovered some ants trying to steal my bullets, I might swat a couple out of sheer reflex, but then I'd study them. Notice that *we* have not been ripped out of the *Javelin*."

"Yet."

It was on the fifth day after the charges had been fired that the bodies started to appear. I woke from a very light and disturbed sleep and had a shower. For some reason, a shower always puts me in a better mood. Getting to sleep is beyond my control, but a shower is as easy as turning a tap. There was a sharp bang nearby, like a gun being fired. It might have been an equipment failure, or worse, a meteor strike. All thoughts of poor sleep and great showers went to the bottom of my priorities list as I hurried to the control hub wearing just a towel. Landi was already there.

The monitor screen showed a naked body lying in a corridor in Zone K. Zooming in with the monitor camera, we saw that the hair and general shape was that of Mikov. The rest was unrecognizable.

"What a mess," I said without thinking.

"Decompression and extreme cold," said Landi. "He's been in hard vacuum."

"Is it real?"

"Water's condensing on it. That doesn't happen with holograms, so it has to be real."

I sent a medical drone to investigate. The results were quite a surprise.

"The body's colder than room temperature, but not much colder," I reported. "I'd say it's been sent from inside Limbo."

Mikov began to lift his left arm. The movement was very, very slow, as if something invisible were controlling the dead limbs, trying to

understand how arms work. Muscles become stiff at low temperatures, and do not work for long if there is no oxygen being supplied to them. This body was showing no signs of breathing. The legs moved a little, then the head turned, and the jaw worked. After a few minutes, the muscles were spent and could do no more than twitch. Mikov vanished, and there was a sharp thump as the air rushed in to fill the space.

"What just happened?" asked Landi.

"Take a garden snail and toss it into your neighbor's yard," I said. "Does it understand the idea of flying through the air? Does it realize that it has traveled farther in a second or two than it could have in days of crawling?"

"Speaking as a snail, I'm more worried about being dropped on a path and squashed."

"I don't think it will come to that," I said, trying to sound reassuring. "Mikov's body was sent here as an experiment. The interior of the *Javelin* must seem like a furnace to the Limbians."

"Have you noticed that we're skirting one very important fact?"

"Tell me."

"We've just seen evidence that the Limbians are aware of this ship. They can track it, send things in and take things out. They are aware of the water in us, and in the reaction mass tanks."

Communication by anything on the electromagnetic spectrum was apparently new to whatever lived within Limbo. They were learning, however. They could take a dead body and make it go through the motions of living. Could they comprehend vision, hearing, and speech? The sound of Mikov's body arriving and displacing its volume in air had been sharp and percussive, just like a meteor strike. Sensors to pick up that sort of noise were scattered right through the *Javelin*.

After three more days, the alarms announced that we had another visitor. It was about the right size and shape for Saral, but it too displayed all the signs of having been in hard vacuum for between five and ten minutes. A medi-drone told us that this corpse was feverishly hot, but there was no pulse. Again the body's limbs moved experimentally, and they were more flexible than those of Mikov's chilled body. The jaw worked, the drone's

stethoscope picked up the wheeze of lungs going through the motions of breathing, and guttural sounds came from the mouth as the vocal chords were put through their paces.

"The Limbians are definitely puzzled by our bodies," I observed.

"They probably don't understand our machines, either," said Landi, automatically looking for a military advantage. "But why open contact with a hostile act?"

I had been thinking about this.

"I don't think it was hostile. Imagine a mosquito trying to probe your brain with a red-hot needle. You would squash it dead, but then you might wonder what sort of mosquito uses a high-tech thermal micro-lance. Would you put the pathetic little smear on your hand under a microscope?"

"Probably."

We had the company of Saral's body for a half hour until the tissues broke down to such an extent that it could no longer move. The Limbians were learning about the care and maintenance of human bodies very quickly.

On the twenty-fifth day since the Limbians became aware of us, the alarm announced a third visitor. As we expected, this time it was Fan, and he was in a much better state of preservation than the others. I steered the nearest medi-drone to him, and it landed on the back of his neck and began to run tests. An auditory scan showed that his heart was beating and that he was taking breaths. His head turned back and forth, and his eyes focused on some nearby instruments. Things that did not understand eyes were looking through his eyes. Touch was probably more important than sight in their dark ocean home.

"Universal cell wall rupturing," I concluded, pointing at the critical status diagnostics from the drone. "This is another dead body being put through the motions of living."

Landi did not reply. She was edgy and uneasy, strangely emotional about this particular corpse.

"Either they're getting better at repairing bodies, or..." I said, fishing for a response.

"Or?" snapped Landi, now looking annoyed.

"Or this body was only in vacuum for a few seconds before the Limbians ripped all three bodies back out of the ring system and into their ocean. Someone must have finally realized what

they were dealing with. From the cell wall damage, I'd say they froze all three bodies, thinking they could bring them back to life."

"I wish you'd stop saying bodies!" cried Landi. "They were our colleagues, our friends."

"Sorry."

This behavior was right out of character for her. If there was an agenda, she was not letting on.

"Well, the Limbians now know that we breathe gasses and prefer an environment of around twenty degrees Celsius," I said. "It would be like us encountering something that lives inside the Sun. The idea of hearing, seeing, walking, and even eating and going to the bathroom must be big-time news to them."

"And they can teleport stuff around," said Landi, thinking in friend-and-foe mode again. "Lucky they don't live in Europa's oceans."

"Yet," I responded.

"What do you mean?"

"They move things about pretty well instantly with some sort of mass-exchange technique, and they can detect ice and water at a distance. How far can their senses reach? Could they follow the *Javelin* back to Earth? Could they mass-exchange themselves to Europa?"

Landi lost color, and instinctively reached down to her belt for a flechette pistol that was a tenth of a light year away, on Earth.

"If they can establish outposts in the oceans of Europa and Ganymede, then pretty soon they'll start studying our research stations there. There are also subsurface seas and oceans within Triton, Enceladus, Pluto, and even Ceres, just to name a few. They are an alternative Goldilocks zone for life, and about ten times more common than Earth-type planets. And speaking of Earth, there are lakes under the ice in Antarctica."

"Then what's left to us humans? The Moon? Mars?"

"It won't do us much good. They can move us about at will, remember? To them we'll be like chimps, or even ants."

"We have to fight back!"

Suddenly Landi was animated and purposeful. If she could fight, she had something to focus on. There was only one problem.

"How?" I asked.

"We could detach the fusion reactor and use the shuttle to put it on a course for Limbo. If we detonate it just above the surface, it will

crack their ice shield open like an egg. No water involved, they'll never see it coming."

"Two hundred miles of ice does not crack like an egg, Landi. It would be annoying, but it would not destroy the Limbians."

"Then we can just blow up the ship here, deny the Limbians the use of ourselves and our ship. We—"

"Eelanjjii!"

The sound was distorted and tortured; to me, it was just vocal chords being flexed.

"He's alive!" Landi exclaimed.

"No way."

"But he called my name."

"His entire body is a mass of ruptured cell walls. Even if he were conscious he'd have no more than minutes to live."

"He's conscious?" she cried, her face suddenly all hope and desperation jammed together.

"Captain Landi—"

But she was not listening. She bounded up from her seat and dashed out of the control room. I followed her for a few paces, then thought better of it and returned to the monitors. I was in time to see Landi kneel down beside Fan and take him in her arms. She ripped off my diagnostic drone and flung it away.

"Fan, can you hear me?" she sobbed. "It's you I love, I just didn't have the guts to tell Mikov. I can't let you die without telling you that."

So they've had an affair? I realized. That was a shock. Fan was Saral's lover. Where had they done it? The *Javelin* was two miles long, but most of that was the linear accelerator for the magnetoplasma drive. The gravity habitat wheel had about the volume of an old-style airliner, but there were monitors everywhere. That left the personal cabins, but our biotelemetry transmitters would show two people experiencing a moderate rise in heart rate and blood pressure in the same cabin when checked. When checked by who? Unless there were a medical emergency, nobody.

Landi and Fan vanished together.

There was one thought pounding through my mind in the moments that I took to make my next decision: *I'll be next*. For the next half hour, I frantically deleted everything in the *Javelin's* navigation files and databases that showed where we had come from, as well as

sending the quick summary of what had happened back to Earth. It was desperate babble from someone plunging into a nightmare, definitely not a good read.

Given enough millennia, Abyss would drift far from the Sun. Meantime, the Sun was the closest interstellar body. Could the Limbians sense gravity as well as water? Human eyes could see light from as far away as the Andromeda galaxy, but with touch one has to reach out. How far could the Limbians reach, and with what senses? So many questions, and only guesses for answers. There was a good chance that Landi would get trashed by whatever passed for Limbian scientists, and that would be very discouraging. Perhaps they would leave me alone, hoping to follow me home as I tried to escape. There was always the option of detonating the fusion reactor, but disaster recovery officers don't like those sorts of options. What, then?

Perhaps I can tell them a story.

I did a search on the most Earth-like planets within a fifty-light-year sphere, looking for something not unrealistically far yet not so close that the final page of my story would arrive too quickly. The Gleise 667 system was perfect. Twenty-two light-years away, and three rocky planets in the Goldilocks zone of a red dwarf in a triple star system. An enormous space telescope had detected water and oxygen on Gleise 667Cc.

In two days, the reaction mass tanks of the *Javelin* would be full. This would mean a very important decision had to be made about the plot of the story I was living. I made it almost without a second thought, then called up Homelink and read from a carefully prepared script.

"In two days I shall begin a burn to send the *Javelin* to the Gleise 667 system. The Limbians have killed the four others of the crew, probably by accident. The care and feeding of humans is, quite literally, alien to them. That leaves me, and I hope to fool them into thinking that the *Javelin* came from the Gleise system. Send no more transmissions, either to Abyss or to where you calculate the *Javelin* to be. If it's safe, I'll send updates. If not, then spare a thought for me. I did my best. Make Earth go radio-frequency silent. The Ground Limbo hardware is still on Limbo's surface, and includes several radios. Eventually the Limbians

might work out a way to use them, and we don't want them hearing signals from Earth. This is the first and last Gleisian signing off."

I now locked the Homelink transceiver array on Gleise 667.

I had one huge advantage over the Limbians: The human body was absolutely alien to them. True, they were getting better at looking after us, but I was now their only undamaged reference. My plan to go to Gleise 667 was ludicrous, but perhaps it seemed too ludicrous to be a lie.

How does one wipe out the memory of an entire world? I deleted most of the ship's databases, their backups and their disaster contingency backups. Hardcopy books went into the plasma pre-processing chamber. I searched the cabins and found dozens of personal data sticks containing everything from documentaries about the *Javelin* expedition to artwork virtual models of our Solar System. I just vaporized any encrypted datasticks.

Finally, when I was too tired to do any more, I sat slumped in front of the navigation screen and called up artwork representations of Gleise 667. It was a triple star system with one M-type and two K-type stars. The M-type red dwarf had three rocky worlds in its habitable zone. True, they were orbiting the dim star closer than Mercury orbits the Sun and were all tidally locked to present the same face to the little star, but the Gargantua telescopic interferometer had detected water and oxygen on the planet designated 667Cc.

I closed my eyes and visualized a band of green and blue girdling a planet that was baked on one side and frozen on the other. Were that the Earth, the livable band might include the eastern half of North America, the western half of South America, most of Antarctica, a sliver of the West Australian coast, half of Indonesia, all of southeast Asia, China and Mongolia, central Siberia and Greenland. That was all the real estate that I needed.

I locked the ship's optical telescope on the star system, then ramped up the magnification. There was not much to see, just the three stars. The planets were only visible with Gargantua, an optical interferometer array that was the size of the Earth's orbit. Gleise 667Cc had been discovered in 2011. The planet itself was no more than a pixilated blob in pictures returned by

Gargantua, but they had confirmed that water and oxygen were present. Water allowed the possibility of life, and oxygen confirmed life's presence. It was a plausible place for a human body to have come from.

With the reaction mass tanks full, I thought through my options yet again. What was the most natural thing that a really frightened animal would do? Were a Pleistocene hunter faced with a saber tooth cat, he would run away. Were a saber tooth cat faced with a human battle tank, he might also run away. Did the Limbians understand fear? If they did not, I had no options at all. I now committed myself to running away.

The *Javelin* was designed to operate with a minimum crew of one, but you do not simply press a button to start the engines on a starship two miles long. There are power levels to be balanced, reaction plasmas to be generated, course coordinates to be configured and emergency systems to be brought online. Most of this work was automated, but it still took days. Having started the process, I had a lot of free time on my hands because the magnetoplasma drive had to be brought up to operating temperature slowly to avoid hysteresis deformation. Being at a loose end, I returned to world building.

A lot of speculative art has been created to describe the worlds that orbit distant stars. Landscapes of Gleise 667Cc were a favorite subject, because it was part of such an exotic system. A search on *Gleise 667Cc* and *Images* returned hundreds of images of one bloated sun and a pair of small, bright suns hovering above ruddy horizons. The skies were banded with clouds, and placid lakes and seas often featured. Some landscapes had dark vegetation in the foreground, and a few had fanciful animals. I deleted all those, along with all artwork for other systems.

Next I printed out dozens of the images of landscapes with three suns, and with these I decorated the walls of the cabins, laboratories, mess room and control centre. They had no buildings, so I labeled them after national parks on Earth.

I searched on images for sunrise in Perth, Singapore, and Beijing, then sunset from New York, Montreal, Lima, and Santiago. There were plenty of pictures in the databases that I had not deleted yet, way more than I wanted a

vastly superior alien intelligence to access, but they also contained every conceivable photograph that I might ever need to build a civilization. I selected photos of dawn and sunset from the appropriate cities, and to these I added triple suns and triple shadows, then printed them to further decorate the walls of the workspaces and cabins.

Mikov came from Vladivostok, I decided, so I selected images of an apartment there and turned it into his home by photopainting images of him into them. Landi got a penthouse in New York with a glorious view of the sunset wastelands to the west. I gave Saral a waterfront property in Lima, and Fan got a place in Beijing with a view of the old Imperial Palace. My real home was in London, which was in the frozen hemisphere, so I chose a freestanding house in a bushland suburb of Perth to live.

I photopasted images of a bigger, more ruddy sun and a pair of stars as bright as the full moon into every landscape picture that I did not delete. Then there were the word problems. Have you ever thought how hard it might be to eliminate the words day or night from the language? There would be no day and night as measures for time on a tidally locked planet. I set a script going on the computers to delete *day* and *night*, and removed *moon* and *lunar* as well. The other planets of my own solar system had to go too.

A model of the Gleise system was in the databases, and from this I projected views of the sky from Gleise 667Cc for dates and times . . . except that dates and times had different meanings here. A year for this world was twenty-eight days long, thirteen times less than an Earth year, and the words day, sunrise, and sunset had no meaning. What was a year? The two K-type stars orbited each other with a forty-two year period, and the red dwarf orbited them in turn at more than ten times the distance. No day, twenty-eight day year, forty-two year star-year, and then there would be another year centuries long for star C to orbit the inner binaries. There would have to be names for all of those periods, along with calendars and legends involving three stars.

There was not much that I could do about the lack of a datastream from the Gleise system, so I fabricated a sudden, inexplicable loss of signal. A radio link over twenty-two light years would require a huge installation, so there

could only be one of them. It was a single point of failure, and I logged myself as assuming that it had failed due to some technical glitch. Repairs might take months, even years, and there was no backup.

All light-year distances had to be multiplied by thirteen to make a new type of light-year. I created names for the stars, names for the planets, units of time, and calendars. The home-world had no seasons, being tidally locked, so I wrote that huge solar flares from the red dwarf stirred up our atmosphere and caused variable weather patterns.

After several days of computer-controlled buildup, the *Javelin's* engine finally came to life. The first few hours of the burn were the worst, I was aware that the Limbians might panic and snatch me away like all the others. The tanks contained millions of tons of water, and I was mostly water. They could track water. I hoped that if they were aware of what the *Javelin* was doing, they would be happy enough to leave me alone. They probably wanted to be led to a planet full of humans, with hundreds of millions of eyes, ears and hands to provide access to an entirely new universe. I had created such a planet, and I was leading them there.

Landi was materialized no more than two yards from me. The blast and shockwave from the displaced air set my ears ringing, then there was a thud as she fell a few inches to the habitat's floor. Like the others, she was naked. Unlike the others, she was uninjured and awake. I shrank back as she sat up and looked around. She displayed no shame at her nakedness as she focused on me, then stood.

Her skin looked like she had spent too long in a bath. Quite possibly the Limbians had created a room temperature chamber of warm, hyper-oxygenated water. There was apparently food available too, because after thirty days away she was not gaunt with starvation. Then I remembered that the Limbians had access to about four-fifty pounds of raw human protein. I did not dwell on that thought.

Landi returning alive was the one possible flaw in my ludicrously desperate plan. She remembered Earth; she was a database that could contradict the illusion of Gleise 667 I had created aboard the *Javelin*. I wondered what I could say to her. In fact, I actually felt a little

embarrassed, like a schoolboy caught drawing doodles of genitalia on his datapad.

"This is . . . familiar," she said. "Where are we?"

"Don't you remember?" I asked. "This our starship, the *Javelin*."

"You . . . are familiar."

"I'm Jander. My name is Jander."

"Name?"

Suddenly I realized that my plan might still be on course. Her memories appeared to be incomplete.

"Name—Identification. I'm Captain Jander, I'm the leader of the crew."

She accepted that. Relief must have radiated from my face like a floodlight, but Limbians did not understand facial expressions. Landi had lost the memory of being captain.

"Do I have a name?"

"Landi. Your name is Landi."

"What is on your skin? Damage?"

Her memory had definitely been scrambled. The Limbians understood injury, but not clothing.

"Clothes, these are clothes," I said, pulling at the cloth. "Protective covers, insulation against cold."

"But it is very hot in here."

"No, it's normal."

Over the next hour, I got Landi into overalls from her locker and established that she remembered eating, drinking, and going to the bathroom. Her speech centers were okay, but nearly everything else was scrambled or absent. It was as if her mind had been taken apart, then put back together by something that did not understand how everything fitted. Quite a few bits had been left out, and one of those was Earth.

I showed Landi her quarters, and pointed to the pictures of her New York apartment with the view of three suns that never set. One picture showed a dinner party with her parents, brother, and his family. She accepted all this without question.

"We're going home now," I concluded. "Our world is called Gelser."

"But we are traveling slowly."

This sent a shiver through my body. She could not have known that unless she was not entirely Landi. Something was sharing her mind, and it was aware of our speed and distance relative to Limbo.

"Yes, it will take many lifetimes to get home," I explained. "We need to travel in suspension vats so that we don't die of old age before we arrive."

"I understand. Clever. What does our world look and feel like?"

Perhaps because the Limbians could not understand what was in her mind, they had returned her without all her memories. I would have to explain everything to her, slowly and patiently. Through her, they could ask me for clarifications. All of that meant that they were afraid of damaging me. That was a great comfort.

"Gelser is in a triple star system," I said. "It orbits Gleise, the smallest of the three stars."

"But what is Gelser?"

"It is a planet orbiting a star the same way that the moons of Abyss orbit. Gelser means band of life. It's more than six thousand light years away. Here is where you live."

I pointed to the printout of New York, with three suns perpetually setting in the west. Getting the triple shadows right had caused me a lot of headaches, but the images were convincing.

Some hours later, Landi needed to sleep. Once I was alone, I took observations of the Doppler shifts of reference stars. They confirmed what I suspected—the *Javelin* was about six thousand tons heavier than it should have been. Although that was a tiny fraction of its mass, it was significant. I checked the tank monitors. One of the reaction mass tanks that should have been empty was now full, with its valves iced shut. We had a stowaway.

For me, routine conversations with Landi became exercises in absolute vigilance. The month no longer existed aboard the *Javelin*, and a year was shorter than what a month had been. I had kept the hour the same, and decreed that humans had a diurnal rhythm twenty-four hours long. The second I defined as the average human heartbeat at rest, and sixty made a minute. The fewer differences that I had to cope with, the better. I kept the week, but made it a quarter of a year. I punished myself by slapping my face every time I even thought the words *day* or *month*. It was easier to think of the weeks as January, April, July, and October, so this was what I did. All the clocks and computers had been reconfigured.

"This is home," I said in one of my tutorials about home, bringing up the image of a large, reddish sun shining over a placid lake on the conference wallscreen. "This is Gleise, the star that we orbit. The two other stars are Fril and Rec."

"What are these fluffy things?" asked Landi,

"Clouds. They're water vapor, steam. This next pic is of another national park. See these things? We call them trees."

"But where is the ice to protect you from the star's heat?"

"The atmosphere gives us enough protection. Our planet is locked into facing the sun, Gleise. Only a narrow band of twilight is habitable. This photograph was taken from further into the sunlit side. See, Gleise is higher in the sky. Here is New York, on the edge of the Atlantic Bandsea. These are cities in China and India. Perth is the capital of Australia. I was born in Perth."

"They are different. Why is that?"

I very nearly said that some cities are in the tropics and the buildings are designed for warmer temperatures, but the tropics did not exist in my new home for humanity.

"It's cultural," I managed. "Different cultures have different ways of doing things."

"What are cultures?"

And so it went. Landi accepted my newly invented calendars and timing systems without question, but I was my own worst enemy. Just try getting through your day without saying day—or night, daily, dusk, dawn, moon, afternoon, tropics, poles, and a multitude of other words that developed on a spinning world. I spoke slowly, rehearsing every sentence in my mind. Landi and I began to settle into a routine that would last the five months of acceleration.

I had never given much thought to our captain's sex life, so my next problem caught me flat footed. I had encouraged Landi to explore the habitat, mainly so that the thing sharing what was left of her mind could see all the pictures supposedly from cities on Gelser. I had not expected her to find a secret home movie database belonging to Saral. Like eating and washing, the skills for using a simple remote had apparently remained in her subconscious. When I came to check on her, she was in Saral's cabin, watching an extremely graphic video of the ship's biologist performing sexual activities with Mikov.

"What are they doing?" Landi asked.

"They . . . are reproductive activities," I said, more slowly than ever. "Men and women put their DNA together to make a child."

"Oh. Why are they doing it on Saral's bed?"

"It's the bouncing up and down. One needs a soft surface to do it."

"And why are they wearing no clothes?"

"Um, for stimulation."

I checked the other videos in Saral's secret database. All were taken in her cabin, and were highly anatomical in theme. Nine of them featured her and Fan, and Mikov was in eleven more. I was acutely embarrassed to see that I featured in only one. Obviously I was not as memorable as the others. A careful inspection of the room revealed a dozen microcameras. The original Landi had not known about Saral and Fan.

"Why did she record these activities?" asked Landi.

"Sentimentality," I replied.

"What is that?"

"It's very hard to explain. Once you get more memories you will understand."

I was undressing for bed when Landi entered my quarters—stark naked.

"I wish to perform reproductive activities," she announced.

Suffice it to say that I managed to perform, although not before considerable effort to get myself stimulated. Part of Landi was coming from something in about six thousand tons of teleported water in tank 18 Delta, and the thought of that was a real damper. Neither was I to get any relief at the end of proceedings, because she had also learned about sleeping with one's partner.

"How long before a child forms?" she asked as we lay in the darkness.

It was just as I suspected. The Limbians were unhappy about me being their one and only benchmark human.

"For us, there will be no child," I replied.

"But why? We did everything correctly."

"My testicles and your ovaries are in storage, back on Gelsar. There's only dummy flesh in their place."

"Why?"

"Prolonged exposure to radiation in deep space damages reproductive tissues. They will be put back after the trip."

"Oh. Then why did Saral do it so many times

with all you males? No child could be produced."

"It was . . . recreation. It feels pleasant, and it's healthy aerobic exercise."

That was a mistake on my part. Landi now insisted on sex with me during every sleep cycle, for our mutual health. I never managed to stop thinking about what was sharing the experience through her, which made it a continuing challenge.

After five months of acceleration, the *Javelin* has now edged up to just under a two hundredth of lightspeed, and I have put Landi into suspension. Without her to watch and listen, I am free to broadcast these words to all of you on Earth.

One tenth of a real lightyear from Earth is a vast and powerful alien . . . alien what? Civilization? The word cannot begin to describe the Limbians, but it will have to do. They value humans highly, because we have senses that they can never duplicate—and we can build machines. We are their only window on the universe of radiation and electromagnetism, and without our eyes they cannot know in what direction to reach out with their fearsome but limited senses. Stay away from Abyss and its moons, and you will be safe.

When I awake, the *Javelin* will have just enough power and reaction mass left to slow down and orbit Gleise 667Cc. All stories are real for those who believe them, and so far my Limbian audience believes my story. That will not last. The Limbians will be disappointed to see that the planet is not overflowing with humans, machines, and cities. Entire continents will not be even remotely like what I have been describing. Worse, there will probably be plants, trees, animals, birds, and fish that are nothing like what are in my pictures. Through Landi, they will demand an explanation, and I will not have one. I shall try to tell a convincing story, and I am a good storyteller, but I am not that good.

The journey to the Gleise 667 system will take four and a half thousand Earth years. That was enough for humanity to go from Stonehenge and pyramids to the *Javelin*, so there is hope. Go forth, achieve marvels and miracles, catch up with Limbian science, and pass them if you can. You have no choice, and there is a deadline. ■

Psi is a problem for science fiction.

Parapsychology has been part of the field since the early days, growing out of the gothic occult and supernatural traditions. By the beginning of the twentieth century, ESP and similar phenomena were being investigated by scientists, which made them fodder for SF. Early books dealing with what would later become known as psionics include Muriel Jaeger's 1927 novel *The Man with Six Senses*, J. D. Beresford's *The Hampdenshire Wonder* (1911), and Olaf Stapledon's *Last and First Men* (1930), which introduced the idea of advanced mental powers being part of the future evolution of the human race.

Psi was a frequent element in pulp SF, including various uses of telepathy, ESP, and telekinesis in E. E. "Doc" Smith's *Skylark* and *Lensman* stories (1930s and onward), a form of ESP in Edmond Hamilton's *The Man Who Evolved* (1931), and telepathy and teleportation in Edgar Rice Burroughs's *Barsroom* series (1917 and onward). As the Campbell Age developed, mental abilities and talents made frequent appearances in works by such seminal Golden Age authors as Robert A. Heinlein, A. E. Van Vogt, Isaac Asimov, and L. Ron Hubbard.

The work of popular parapsychologist J. B. Rhine (beginning with *Extra-Sensory Perception* in 1934) brought psi into the mainstream. After World War II, Campbell became a devotee of Rhine and psionics enjoyed a huge expansion in the pages of *Ashtounding* and beyond. (It was about this time, in fact, that the word "psionics" emerged, as an analog to "electronics," to describe the treatment of ESP in a scientific fashion.)

This period included such works as Theodore Sturgeon's *More Than Human* (1953), John Brunner's *The Whole Man* (1964), James Blish's *Jack of Eagles* (1952), Alfred Bester's *The Demolished Man* (1953)

and *The Stars My Destination* (1956), Zenna Henderson's stories of *The People* (collected in *Pilgrimage*, 1961, and *The People: No Different Flesh*, 1966), Clarke's *Childhood's End* (1953), and Frank Herbert's *Dune* series (1965 and onward).

Psionics has continued to be part of SF up until the present day. The early years of this century saw a resurgence of paranormal themes in all genres of fiction. By now, psionics is a generally accepted convention of the SF field just like space travel, alien beings, artificial intelligence, and dozens of others.

And there's the problem. Psi is one of three great SF themes that seem to violate the laws of physics (time travel and faster-than-light travel being the other two). Like the other two, psi has been "grandfathered in"—it's such an integral part of the field that it's just too hard to get rid of. Instead, most SF writers adopt the practice of treating psi in a scientific fashion, as if it were an existing phenomenon that follows the same sort of laws as do other sciences.

There is in hard SF a movement—popularized by Neal Stephenson, among others—to write without resorting to FTL, psi, or other "counterfactual" technologies. In these works you'll find no telepathy, telekinesis, or mind-transfer.

Regardless, SF is a house with many mansions, and if you don't mind reading about psionics, you can certainly find what you're looking for. For example:

The Galaxy Game

Karen Lord

Del Rey, 336 pages, \$15.00 (trade paperback)
iBooks, Kindle, Nook: \$9.99 (ebook)

ISBN: 978-0-345-53407-1

Genre: Coming of Age, Psionics

Karen Lord's *The Best of All Possible Worlds* (reviewed in the June 2013 issue) was

a psychological and sociological story of displaced refugees settling on Cygnus Beta, a world that welcomes all of the galaxy's peoples. Now she returns to Cygnus Beta for a coming of age tale featuring three psi-gifted youngsters. Although bright teens can certainly enjoy this book, *The Galaxy Game* is not a young adult book—it's firmly pitched toward adults.

Cygnus Beta is home to the Lyceum: a school for the galaxy's psionics. The story focuses on three particular students: Serendipity, the peacemaker; Ntenman, the rebel; and Rafi, perhaps the most gifted of them all. All three chafe at the restrictions of the Lyceum, Rafi the most. His sole measure of freedom is Wallrunning, an athletic contest of mind and muscle against changing gravity fields, played on a field of vast vertical walls.

Of course, all is not as it seems. The civilized galaxy, populated by multiple human species, is convulsed by politics. Some factions want to control Rafi and the others in order to use their mental powers—others, seeing their powers as threats, want to imprison them.

As the political machinations come to a head, wiser heads help Rafi and his friends escape to distant Panartum, a supposedly safer world. (These wiser heads include Delarua and Dllenankh, whose love story was at the center of *The Best of All Possible Worlds*; their appearance is like the arrival of old friends.)

Naturally, Panartum isn't the safe haven everyone hoped, and Rafi and his friends are on the run across the galaxy. And as Rafi moves deeper into the world of competitive Wallrunning, he begins to realize that this hobby of his may hold more mystery . . . and lead to more power . . . than he ever dreamed.

Adventure, exotic societies, convoluted politics, and the creative use of psi drawing it all together—what's not to like?

A Murder of Clones

Kristine Kathryn Rusch

WMG, 380 pages, \$18.99 (trade paperback)

iBooks, Kindle, Nook: \$5.99 (ebook)

ISBN: 978-1-56146-608-5

Series: Anniversary Day 3; Retrieval Artist 10

Search & Recovery

Kristine Kathryn Rusch

WMG, 248 pages, \$18.99 (trade paperback)

iBooks, Kindle: \$5.99 (ebook)

ISBN: 978-1-56146-615-3

Series: Anniversary Day 4; Retrieval Artist 11

The Peyti Crisis

Kristine Kathryn Rusch

WMG, 364 pages, \$18.99 (trade paperback)

iBooks, Kindle: \$5.99 (ebook)

ISBN: 978-1-56146-616-0

Series: Anniversary Day 5; Retrieval Artist 12

Genre: SF Thriller

Kristine Kathryn Rusch's Retrieval Artist books are SF thrillers set in a universe teeming with alien life and cultures; Humans are the new kids on the block. In *Anniversary Day* (reviewed in the June 2012 issue), Rusch started a new saga with a rash of terrorist bombings by clones on the Moon (on Anniversary Day, of course). Security Chief Noelle DeRicci, tasked with tracking down those responsible, uncovered a conspiracy that threatened the whole of the inhabited Moon.

In the second book, *Blowback*, DeRicci enlisted the aid of Miles Flint, the series hero, as they attempted to forestall upcoming attacks. The mystery deepened and the thrills got more intense.

If you enjoyed the first two Anniversary Day books, take a deep breath and tighten your seat belt; the saga is moving into high gear. Rusch has written the next six (!) books in the saga, and they're coming out one a month. The three listed here are the third through fifth titles.

A Murder of Clones (book 3) involves Earth Alliance Frontier Marshall Judita Gomez. Spurred by the Anniversary Day attacks, Gomez defies orders and reopens a cold case from her past, one involving the murder of clones. But investigation of that old case leads Gomez and her crew too close to answers that someone doesn't want known—leaving them in mortal danger.

Search & Recovery (book 4) focuses on Luc Deshin, a reformed criminal and one of the most powerful and feared people on the Moon. In the wake of the Anniversary Day bombings, Deshin realizes that his family is in

danger. For them, he returns to the black market underworld in his own attempt to track down the perpetrators. He discovers a major piece of the puzzle.

The Peyti Crisis (book 5) takes place immediately after *Blowback*, and draws together threads from all the previous books. Miles Flint is firmly in charge now, along with his partner Bartholomew Nyquist. As they uncover more and more about the conspiracy, racing against the clock to prevent further attacks, millions of lives hang in the balance.

The Retrieval Artist universe is rich and exciting, and Rusch's characters are real beings (Human and otherwise) struggling against overwhelming odds. The thrills are nonstop, and the tension keeps increasing with each successive book. If you're a nail-biter, you might want to wear gloves for these.

While you can technically read books 3 and 4 out of order, you've going to want to read 1-4 before you tackle 5. I suspect that the next three titles may be more sequential. In any case, the best way to read this saga is from beginning to end in order. If your budget is like mine, you might want to go for the ebooks.

Superposition

David Walton

Pyr, 285 pages, \$17.00 (trade paperback)

Kindle: \$9.59, Nook: \$10.49 (ebook)

ISBN: 978-1-63388-012-2

Series: *Superposition 1*

Genre: SF/Mystery

Jacob Kelley has a great life. Disgusted with the intrusion of politics into scientific research, Kelley gave up a promising career as a leading particle physicist for a position as physics professor at Swarthmore. Now happily married and with two beloved children, Jacob hardly thinks about his past life—until a former colleague, Brian Vanderhall, arrives in the middle of the night with a gun, raving about alien quantum intelligences.

Things go from bad to worse a few days later, when Vanderhall is found dead in an underground bunker . . . murdered the day before he showed up at Jacob's house. Still worse, Jacob is arrested and put on trial for the murder of his old friend.

With the help of his teenage daughter Alessandra, Jacob searches for the real murderer. And then things start to get strange.

There *are* quantum aliens all right, along with parallel universes, entangled objects, new technology, and multiple versions of everyone involved. And Jacob realizes that it isn't just his own fate at stake—the lives of his family, his friends, and everyone on several Earths are in danger.

Thriller, mystery story, and tale of cutting-edge science all packed between the same covers, *Superposition* is a wild ride from beginning to end. It's impossible not to like Jacob Kelley, and daughter Alessandra is the kind of bright, feisty teenager that every parent wants to raise.

Fair warning: this is the first book of a "duology" (which, in my youth, we called "a book and its sequel"). *Superposition* comes to a satisfying ending, but there are enough loose ends that you'll definitely be looking forward to the next book.

Inside a Silver Box

Walter Mosley

Tor, 304 pages, \$25.99 (hardcover)

iBooks, Kindle, Nook: \$12.99 (ebook)

ISBN: 978-0-7653-7521-6

Genre: Literary SF, Visitors From Space

Walter Mosley, best known for his mystery novels, hails from the literary side of town. When he turns his hand to science fiction, he usually brings some fresh takes on familiar genre tropes. *Blue Light* (1998) was an SF/horror blend involving a mysterious extraterrestrial light that gave ordinary humans special powers; *Futureland* (2001) was a collection of stories set in a post-apocalyptic future. In *The Wave* (2007), an eons-old organism resurrects the dead.

Ronnie Bottoms is a New York thug, and Lorraine Fell is one of his victims. An encounter in the park leaves Lorraine dead and Ronnie arrested—but then Lorraine comes back and tells Ronnie he must revive her by using the Silver Box.

The Silver Box, perhaps the most important object in the Universe, is an alien tool of enormous power. And now Ronnie and Lorraine are its guardians.

The Box once belonged to the Laz, an evil alien race who will stop at nothing to regain it. With the Box, the Laz will be able to resurrect their tyrannical leader and rule the Universe.

Since the Silver Box possesses some form of sapience and morality, it will not allow itself to be retaken . . . even if it has to use Ronnie and Lorraine to destroy the Earth in its defense.

There's a lot more going on in this book than an adventure story of alien tech gone crazy. The story of how Ronnie and Lorraine learn to work together, and to grapple with the complexities of the Silver Box and the threats it engenders, is compelling and inspiring.

This one reminds me of some of the work of Ray Bradbury and Theodore Sturgeon. Definitely worth a read.

Edge of Dark

Brenda Cooper

Pyr, 410 pages, \$18.00 (trade paperback)

Kindle: \$9.59, Nook: \$10.49 (ebook)

ISBN: 978-1-63388-050-4

Series: Glittering Edge 1

Genre: Artificial Intelligence, Space Opera, Transhuman SF

What do you do when you create an artificial intelligence that's vastly superior to humanity and also a threat to everything you hold dear—and you find that you can't turn it off? If you're the people of Brenda Cooper's

transhuman universe, you banish the thing to the edge of the planetary system, where the pale light of the distant star will keep it in starved hibernation, struggling just to survive.

At least that's the theory.

A theory that's tested by three people. Nona Hall is a privileged scion of the system's most powerful family, living amid the riches of the station Diamond Deep. Charlie Windar is a ranger on a planetary nature preserve, devoted to the natural life. And Chrystal, Nona's best friend, just happened to awaken one morning in a robot body.

In the best space opera tradition, these three become entangled with the banished AI, which hasn't been hibernating at all . . . in fact, it's been learning and growing, and now it wants to come back in out of the cold. . . .

This is one of those total-immersion books where the reader is thrown into an unfamiliar world—but Brenda Cooper is a friendly and competent guide, and you'll get your bearings soon enough.

This is another duology, so don't expect a full resolution at the end.

And now my psionic abilities are telling me that my space is up. I'll foresee you next issue. ■

Don Sakers is the author of *Children of the Eighth Day* and *Meat and Machine*. For more information, visit www.scattered-worlds.com.

Dear Mr. Quachri,
I am writing to thank you for the summary of past appearances provided at the start of “Defender of Worms” in the January/February issue. Many times in recent issues I have started reading a story only to wrestle with a nagging sense of déjà vu for the first few pages. *Wait, I think we’ve seen this character before. Which aliens are these? Where did we leave off last time? Aren’t there two series with a barbarian in a future dystopia exploring the world beyond his village?* The need to recreate what’s happened previously prevents me from fully immersing myself in the story. It was such a pleasure to see a concise review so I could skip over the imprecise flashback stage and go directly to enjoying the new story. And it was especially appreciated that the summary was at the beginning of the story, so the context was provided where it was most useful. Please make this a regular feature! It is a wonderful service for those of us who look forward to *Analog* each month but have trouble keeping track of details from stories that appeared months or years previously.

While I have your attention, I would also like to thank you for choosing such wonderful stories. The past few issues have contained a wonderful mix, every one of which was worth reading. I look forward to enjoying your selections for many more issues to come.

Elka Tovah Davidoff
Malden, MA

Dear Editor,

Thank you SO much for putting the synopsis of previous stories from a “universe” at the START of the current story rather than at the end, and for amplifying the synopsis with previous story outlines. *Analog* serials have always (in my experience) put extended character and plot refreshers at the start of every episode after the first. Arguably, it’s probably more important to put the refreshers for non-serialized but related stories there as well, since those stories can be spread over years and the connections fade in readers’ minds

(mine, anyway) over time. I’m deep into “Defender of Worms” right now, a serious page-turner. The references to past episodes in the story arc are fleeting but important. Being reminded that I SHOULD recognize names and events from previous stories makes the story all the more comprehensible. I wouldn’t even mind a half-page or so of refresher for as complex a story as that of Brittany, Floyd, and Memphis.

Again, thanks for making life easier for the reader.

Tom Powers
(40+ year subscriber and
cover-to-cover reader)

PS: I also like the guest editorials. No offence intended to Stanley, but I would have preferred a half-time inclusion of alternatives to his editorials as well.

Dear Editor Quachri,

Hi! I hope that you are doing well. Just a note to let you know how much I enjoyed the Jan/Feb 2015 issue of *Analog* magazine.

I especially enjoyed “Usher” by Jay Werkheiser. The story concerns a man who is visually and hearing impaired who is called in to attempt to communicate with aliens. He discovers that the aliens communicate using magnetic fields, and they see by detecting spectral patterns of absorption and emission. I really enjoyed the absorbing science-based speculative ideas backed up with believable explanations and any necessary scientific background to support them. This story was very inventive and original, and was fun to read. It had fascinating characters and character interactions, and an absorbing, gripping plot.

I also very much enjoyed the latest installment of sentient AI implant Brittany and her ex-host Floyd in “Defender of Worms” by Richard A. Lovett. The story had multiple and interesting plots and great characters. I enjoyed the speculative, science-based objects and ideas in the story. For example, the aliens in the story had devices in the shapes of rosettes on their ship that were possible artificial-gravity

generators. These rosettes may have resembled the bodies of the aliens themselves. The aliens also may have seen mostly in the infrared, showing that other beings may have completely different sense receptors and perceptions than humans.

Finally, I greatly enjoyed "Orbits to Order" by Stanley Schmidt. He explained the mathematical details involved in producing synchronous orbits for satellites at different altitudes, and he also detailed the mathematics governing satellites orbiting much faster or slower than in natural orbits. These modified orbits could be produced by adding a positive or negative centripetal force. Stan gave clear, lucid explanations of the sometimes non-intuitive concepts involved. I learned a great deal from this article, which included many interesting background details regarding orbits and the mathematics that govern them.

Thank you to everyone who contributed to this issue of *Analog*. It is greatly appreciated!

David McAlaster
Ashland, Oregon

Mr. Quachri,

I read *Analog* for the hard science fiction and the hard science articles. Your January/February 2015 issue disappointed in both areas.

"Why the Titanic Hit the Iceberg" by Jerry Olton is nothing but politics with a thin wrapper of story. Worse, what little story there is can best be described as class warfare snuff porn rather than science fiction. If Mr. Olton wants to vent about his two-dimensional caricatures of those more wealthy than himself, that's his prerogative. *Analog*, however, should not be the venue in which he does so.

Less blatant but still obtrusive and unnecessary are Rajnar Vajra's snide asides about companies' profit motives in the guest editorial "Here's to Your Health." Mr. Vajra's credulous treatment of unproven treatments is not improved by the soupçon of his political views.

Analog has a great reputation for delivering consistently high-quality hard science fiction. Please continue that tradition and eschew these gratuitous polemics. "If you want to send a message, call Western Union."

Patrick May

* * *

There's no denying that "Why The Titanic Hit the Iceberg" is a political—even intensely political—story. But it is most definitely still a story. Sorry you didn't care for it.

As to your other point: Well, there's a grand Campbellian tradition of espousing all sorts of things in editorials, guest or otherwise. That includes political views, avowals of various beliefs that would be out of place in a fact article, and more. That's what editorials are for; they're opinion pieces at heart.

Dear Mr. Quachri,

This is to thank Mr. Don Sakers for his work on the Reference Library and especially for his November 2014 column. First to say thank you for the call out to our military. I am a long-career veteran of the military and appreciate the acknowledgement. That is probably one reason I enjoy military SF, or stories in a similar style, more than most.

Second, I was bemused with Mr. Sakers' short sermon about the "controversy . . . roiling the waters of SF readership lately." I suppose I should not have been surprised, but after following Mr. Sakers' advice for how to "catch up" with the goings on, I can only say I agree with Mr. Sakers' comments entirely. All I would add is the thought that history suggests that the very sort of militaristic, even brutal, governance that seems such an unwelcome idea is almost guaranteed to reemerge as a result of the situation. Action, reasoned or not, will always occur eventually!

Please keep the Reference Library going!

Gerald Reas
Tucson, Arizona

Dear Editor Quachri,

Among your excellent choices for this year's science fiction, I find myself hopelessly engaged in a repeating loop between "The Homecoming" [June 2014] and "Malnutrition" [January/February 2015].

Since I almost have these two works memorized, I respectfully implore you to publish additional selections by J. T. Sharrah to mitigate my developing affliction of vertigo.

With his mystic worlds, engaging plots, colorful metaphors, and precise adjectives, I thought that I was reading Jack Vance.

Best Regards,
Russel Bauer ■

UPCOMING EVENTS Anthony Lewis

NOTE: Membership rates and other details often change after we have gone to press. Check the websites for the most recent information.

22-24 May 2015

BAYCON 2015 (San Francisco bay area SF conference) at Hyatt Regency Santa Clara, Santa Clara, CA. Theme: Women of Wonder. Writer Guest of Honor: Seanan McGuire; Artist Guest of Honor: Stephanie Pui-Mun Law; TM Guest of Honor: Amber Benson; Fan Guest of Honor: Caradwen "Sabre" Braskat-Arellanes. Membership: \$60 adult (>12), \$25 youth (8-12) until 18 May 2015. Info: <http://baycon.org/bcwp/about/contact-us/>; P.O. Box 62108, Sunnyvale, CA 94088-2108.

22-26 May 2015

BALTICON 49 (Maryland regional SF conference) at Hunt Valley Inn, Hunt Valley, MD. Guest of Honor: Jo Walton; Ruth Sanderson (artist); Erica Neely (musician). Membership: \$60 adult (>12), \$30 youth (6-12) until 5 April, \$65/\$33 thereafter and at the door. Info: www.balticon.org.

19-21 June 2015

DUCKON 24 (Chicago area family-friendly science fiction and fantasy convention) at Westin Chicago North Shore, Wheeling, IL Info: <http://duckon.org/>, info@duckon.org, +1.331.444.2382, DuckKon, P.O. Box 4843, Wheaton, IL 60189-4843

19-21 June 2015

APOLLOCON (Houston area SF conference) at Westin Houston Memorial City, Houston, TX. Guest of Honor: Jim C. Hines; Music Guest of Honor: Tim Griffin; Artist Guest of Honor: Maria William. Membership: \$30 until 1 May 2015, \$40 at the door. Info: apollocon.org; P.O. Box 541822, Houston, TX 77254

25-28 June 2015

LEPRECON 41 (Phoenix area SF conference) at Embassy Suites Phoenix North, Phoenix, AZ. Guests of Honor: Ken Kelly, Larry Hama, Jennifer Brozek, Camille and Kennerly—the Harp Twins. Membership: \$35 adult, \$17.50 child (13-18), child under 12 free. Info: leprecon.org.

26-28 June 2015

SOONERCON 22 (Oklahoma City area spec-fic conference) at Reed Conference Center & Sheraton Hotel, Midwest City, OK. Literary Guest of Honor: Elizabeth Moon; Artist Guest of Honor: Lubov; YA Guest of Honor: Rachel Caine; TM: Selina Rosen; MC: Peter Pixie; and Featured Guests Robert Picardo, Jamie Marchi. Info: www.soonercon.com; info@soonercon.com, SoonerCon Syndicate, 1848 Hemingway Drive, Edmond, OK 73013

19-23 August 2015

SASQUAN (73rd World Science Fiction Convention) at Spokane Convention Center, Spokane, WA. Guests of Honor: Brad Foster, David Gerrold, Vonda N. McIntyre, Tom Smith, Leslie Turek. Membership: currently. Attending \$170 adult, \$90 young adult (17-21), \$70 child (6-16), \$40. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Nominate and vote for the Hugos. Info: sasquan.org/; info@sasquan.org; 15127 Main Street East, Suite 104, PMB 208, Sumner WA 98390.

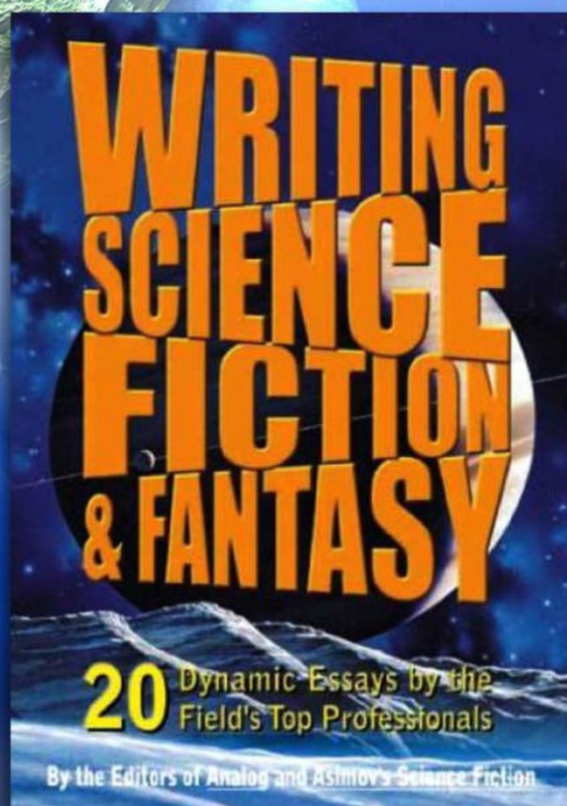
Attending a convention? When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an International Reply Coupon if the convention is in a different country. ■

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